

62 PAGES OF CAR CARE KNOW-HOW FROM EXPERTS

MAY 1975 75 CENTS

Popular Mechanics



**BONUS:
COMPLETE IN
THIS ISSUE**

**CITIES IN THE SKY: YOUR CHILDREN
WILL LIVE IN THEM**

**BE A PANELING PRO: 7 PAGES
OF EXPERTS' SECRETS**

**19 GREAT GADGETS
FOR STEREO SWITCHING**

**BUILD A 762-MM TELE
LENS FOR \$35**

**12 DANDY LITTLE
OUTBOARD
MOTORS**

SUPERTANKER 12

**Oil-Bloated
Supertankers:
Super Menace**



Loop-Charged 70. More getaways per gallon.

Pulling the great escape has to be one of the best parts of boating. And our 70 hp Looper makes it even better. Because it doesn't take much gas to island hop away from the crowd:

Loop-Charging is one way we get the most out of a gallon of gas. It brings in the new fuel charge while pushing out exhaust in one continuous power loop.

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Exhaust tuning uses the energy of sound waves to clear exhaust gases



from the combustion chamber. Then packs in a cleaner fuel/air mixture to deliver more power on less gas.

Patented Pressure-Back piston rings seal the combustion chamber better, so we can use two rings per cylinder instead of three, for less friction, more fuel efficiency.

MagFlash™ capacitor discharge ignition gives fast, sure starts. Smooth, gas saving running from troll to top speed.

See our gas saving 70 and our 50 and 75 horsepower Loopers at your Johnson dealer. Look over all 13 power choices—2 to 135 hp plus four new high-thrust electric maneuvering motors.

Or write for free catalog. Johnson Outboards, Division Outboard Marine Corp., Sea-Horse Drive, Waukegan, Illinois 60085, Dept. PM-55



Performance-engineered by the world leader



First in Dependability

Johnson
OUTBOARDS



Malibu Six Sedan.

**The
lowest-priced
sedan.
\$3402.***

It's the Chevelle Malibu Six four-door above. For many, the ideal family car. It's large enough to give you room for six people, yet remains easy to drive and park. And has all the benefits of Chevrolet's new Efficiency System.

According to the EPA Buyer's Guide, a '75 Chevelle with standard 6-cylinder engine got 16 miles to the gallon in the city test, 21 in the highway test. Now look at the styling. Now look at the price. Good reasons why Chevelle is America's favorite mid-size car.

AMERICA'S LOWEST-PRICED MID-SIZE CARS ARE BOTH CHEVELLES.

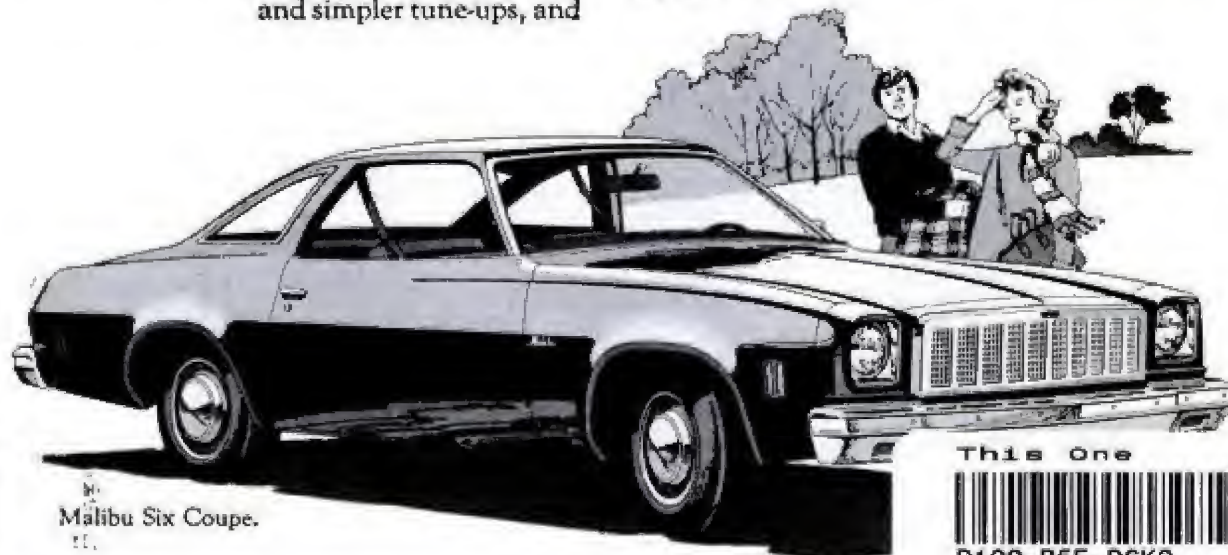
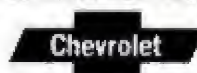
**The
lowest-priced
coupe.
\$3407.***

It's the Chevelle Malibu Six two-door below. Meaning what? Meaning first and foremost, you get Chevrolet's new Efficiency System. So, compared to a '74 Chevelle, you save on scheduled maintenance with fewer and simpler tune-ups, and

more miles between oil changes and chassis lube. Plus a neat, manageable size with seating for six. Now look at its styling. Now look at its price. See why Chevelle is America's favorite mid-size? It's a good buy.

**Now that
makes sense**

CHEVROLET
MAKES SENSE FOR AMERICA.



Malibu Six Coupe.

This One

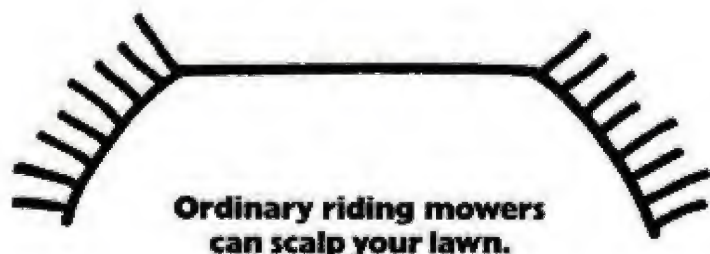


D100-B5E-D6KC



*Manufacturer's Suggested Retail Price, including dealer new vehicle preparation charge. Destination charges, available equipment, state or local taxes are additional.

Did you know that cutting grass with a Homelite riding mower can actually prevent baldness?



If the earth were perfectly flat, any riding mower would be perfectly fine. Unfortunately, lawns have their ups and downs. And that's where most riding mowers run into trouble.

Their mower decks are attached to the chassis, which gives them absolutely no give. When they run into a bump or incline, they level it. Leaving your lawn with a bald spot.

Homelite riding mowers are designed to prevent this. The mower deck is attached to the front suspension. As the wheels glide over a high spot, the deck glides over it too. Leaving your lawn manicured instead of scalped.

In addition, the cutting blades are reinforced with rigid steel to keep the ends from sagging. So your lawn always looks even instead of odd.

And not only are Homelite riding mowers easy on your lawn, they're easy on you too.

They have practically effortless steering. Full plush seats that are fully adjustable. And electric starting is standard on our deluxe 8 hp. model. (Optional on 5 hp.)

To ease your lot even further, optional accessories include: a 5-



bushel grass catcher, 1000 lb. capacity dump cart and a lawn roller.

Should the need for service arise, we back up our dealers with more factory service branches than any other riding mower company. And that does away with long waits for parts or service which could cause your lawn to lose its looks.



HOMELITE® RIDING MOWERS.
They're as easy on your lawn as they are on you.

Homelite, a **Textron** division, Port Chester, N.Y. 10573.

Yes, there's still such a thing as a bargain.



\$1695⁰⁰
F.O.B.
Lapeer, Mich.

Empire...the camper so big, so beautiful and comfortable, you'll wonder how we got the price so low.



Bumper, spare tire, wheel covers and privacy curtains illustrated are extra-cost options.

It isn't just the price that makes the new Empire such a bargain.

It's what you get in the bargain.

Namely, the room, the comfort and beauty of camping trailers costing a lot more.

So we don't blame you for wondering how we did it.

Because, believe us, it wasn't easy.

Not when you give a camper a living area nearly 19 feet long, with sleeping and dining accommodations for up to eight persons. And a fully equipped kitchen including range, sink and ice box.

Or, when you add things like double beds with soft-foam mattresses. And luxurious fabric-and-vinyl upholstery. And rich-looking

woodgrain cabinets and trim. And plenty of storage capacity. Plus, an insulated hardtop roof.

What's more, you get a choice of three different floor plans, with sleeping and dining accommodations for either six or eight.

All at no extra charge.

Because with Empire, a bargain is a bargain.

And this is one to see before you buy any other camping trailer.

For the name of your nearest Empire dealer, write the Vesely Company, Box 465, Lapeer, Michigan. 48446.

Empire®

A division of the Vesely Company — makers of Apache, Pawnee & Empire recreational vehicles.



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ON THE COVER

Oil-bloated supertankers: They can spell disaster for our shorelines. See page 71 for selections from the book, *Supership*, by Noël Mostert. Illustration, Roy Grinnell

AS A SERVICE TO READERS, *Popular Mechanics* publishes newsworthy products, techniques and scientific and technological developments. Due to possible variance in the quality and condition of materials and workmanship, *Popular Mechanics* cannot assume responsibility for proper application of techniques or proper and safe functioning of manufactured products or reader-built projects resulting from plans published in this magazine.

MAY 1975 • Vol. 143 No. 5

INTERNATIONAL EDITIONS: Australia, Caribbean, Mexico, Southern Hemisphere

SPECIAL FEATURES:

PM's Car Care Guide: All the expert know-how you need to keep your car looking better and running smoother mile after mile. Starts on page 109.

Cities in the sky. Scientists are working out a bold new plan to put entire Earth-like communities into space—in possibly 20 years. Page 94.

How to work with plywood paneling. Seven pages of secrets from the experts show you the installation tricks you need to panel like a pro. Page 88.

Stereo switchers: Here's a roundup of 19 different switchboxes and patchboards to handle your many new stereo-system accessories. Page 74.

Build this 762-mm lens for \$35—if you now have a camera bellows—and get 15 times the image size of your 35-mm camera's normal lens. Page 86.

Mini rigs for maxi action. Little kickers with added muscle are earning a new popularity as fuel gets shorter in supply and prices go up. Page 77.



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WORTH WRITING FOR

Looking for more ideas and information? See page 184.

POPULAR MECHANICS IS PUBLISHED MONTHLY by the Hearst Corporation, 224 West 57th Street, New York, N.Y. 10019, U.S.A. Single copy for the United States and Canada, 75 cents. Subscription prices: United States and Possessions, \$7.00 for one year, \$13.00 for two years; \$18.00 for three years. Canada, add \$2.00 for each year. All other countries, add \$5.00 for each year. When changing address, give old address as well as the new, with zip code, and allow six weeks for change to become effective. Second-class postage paid at New York, N.Y., and at additional mailing offices. Authorized as second-class mail by the Post Office Department, Ottawa, and for payment of postage in cash. Registered as second-class matter at the Post Office at Mexico, D.F., Mexico, June 20, 1950. © 1975 by The Hearst Corporation. All rights reserved. Printed in U.S.A. Mail all Postmaster notices of undeliverable copies to Popular Mechanics, P.O. Box 846, New York, N.Y. 10019.

BEFORE YOU BUY A STERN DRIVE, TEST DRIVE THIS AD!

Ideally, you should test drive the boat you've chosen with an OMC Stern Drive, and MerCruiser or Volvo.

But, let's face it, such a test isn't easy to arrange. That's unfortunate (for you!) because OMC's superior combination of performance features really show up in an actual comparison.

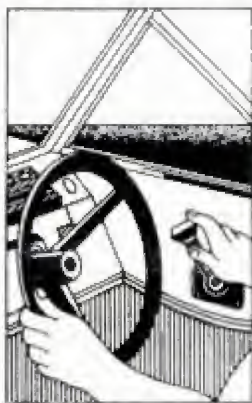
So, compare OMC with the others right on this page. It's the next best thing to actually driving the boats.

Tru-Course Steering

This will spoil you. Engineers call OMC's optional Tru-Course Steering "a

non-reversing system that isolates steering loads from the wheel." In other words—when you turn the wheel, the wheel doesn't fight back. You don't have to wrestle it to hold course

or while trimming. In fact, you can take your hands off the wheel in a turn or straight ahead—at trolling speeds, or at any speed.



Better Maneuvering

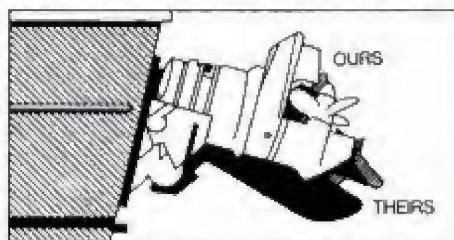
You're in for a surprise the first time you put an OMC into a tight maneuver. Because the OMC outdrive swings 90°... 50% more than the others! In fact, an OMC powered boat can literally turn inside the other two. Just look at the diagram at the right. Isn't that the extra margin you want for maneuvering into a tight slip?



In verified tests with 21' boats—at identical speeds—OMC turned in 16'1", MerCruiser in 34'10" and Volvo in 38'8".

The 75° Hi-Tilt

Only the OMC outdrive tilts up 75°—that's 25% higher than the MerCruiser or Volvo! A big advantage everytime you launch your boat from a trailer, beach it, or want to



change a prop without getting into the water, or hauling the boat out of the water.

The Uni-Mount Difference

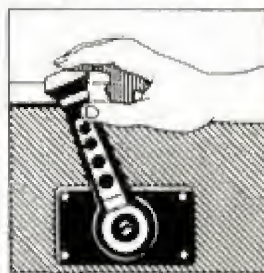
If you put your hand on the transom of the boat with an OMC Stern Drive and then do the same with MerCruiser or Volvo, you'll notice how much more the others vibrate. You can feel and hear the difference. That's because the others bolt the outdrive directly to the transom.

But OMC uses the Uni-Mount system. The outdrive and engine are an

integral unit, cushion mounted to the hull stringers. The outdrive doesn't touch any part of the transom. That's how we dampen gear train and propeller vibration and noise.

Exclusive Power Shift

When you shift the other stern drives, you do it with muscle. When you shift ours, you do it with power. Just move the control as smoothly and easily as the automatic shift lever in



your automobile. And it takes only a 22° movement of OMC's shift lever to go into forward or reverse. The others take 40° to 45°—which

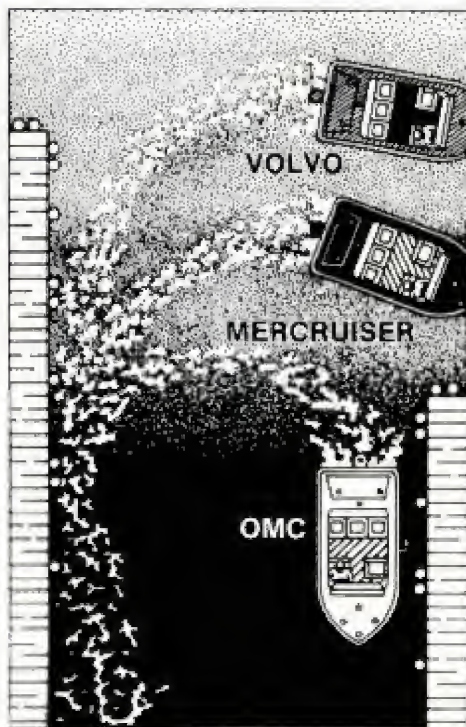
means slower response.

Check The OMC Test Charts

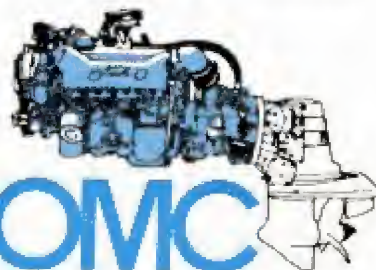
Want even more proof? Ask your dealer to show you the carefully documented OMC V-8 speed and fuel consumption tests.* Check OMC's winning V-8 fuel economy compared to competitors' engines of similar horsepower.

Now you're ready to buy your boat, with an OMC Stern Drive. There are fourteen models to choose from, including five top-performing V-8's.

*Verified by independent marine test laboratory.



FROM THE MAKERS OF
JOHNSON & EVINRUDE



OMC
Stern Drive

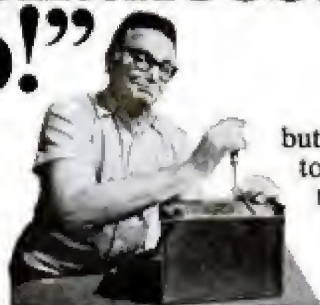
A DIVISION OF OUTBOARD MARINE CORPORATION
3145 CENTRAL AVENUE, WAUKEGAN, ILLINOIS 60085

Henry Morgan says:

"If I can learn to fix my own appliances... you can too!"

"I have 10 thumbs . . . five on each hand. So fixing appliances hasn't been one of my strong points. But I saw an ad that said they could teach me all I need to know . . . at home, in my spare time. I sent for the NRI catalog on their course in Servicing Electrical Appliances . . . and it looked like a pretty good deal. Now that I'm into the course, I can tell you this: it's the only thing I've ever sent away for that was even better than they said it was!"

Now I can thumb my nose at the repairman. I really can do it myself. Not just the toaster or mixer,



but the big stuff, too . . . like the washer, oven, even the lawn mower engine.

They give you everything you need. Bite-size lessons you can handle, with an experienced instructor ready if you need help. You even build the professional appliance tester that the pros use for trouble shooting and repairs.

The course is short, it doesn't cost very much, and you'll soon find yourself picking up spare time money doing repairs for other people. They even show you how to set up your own business, if you've a mind to.

Find out for yourself. Send for the free catalog. If I can do it, so can you."

Henry Morgan

RUSH COUPON FOR FREE CATALOG.

No Salesman will call

Please send me your free catalog "Servicing Electrical Appliances". 600-055

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Advertising Production Manager

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Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.



Longer...
yet
milder



Pall Mall Gold 100's

19 mg. "tar", 1.4 mg. nicotine av. per cigarette, FTC Report Oct. '74.

MAY 1975 7

Manufactured by American Tobacco Company, Winston-Salem, N.C.

**America's favorite
do-it-yourself tool
of 1001 uses!**

ARROW

HEAVY DUTY
STAPLE GUN TACKER

**SHOOTS A STAPLE
WHEREVER YOU'D
DRIVE A NAIL!**



Uses T-50
Staples in 6 Sizes
from 1/4" to 9/16" and Ceiltile

This powerful Arrow all-purpose tacking tool automatically drives staples with one squeeze ease . . . into the hardest wood, plywood, composition board, Masonite, plastic — even soft metal! One-hand operation leaves other hand free. All-steel with chrome finish. Jam-proof.

**FASTER . . . BETTER . . . CHEAPER
FOR FASTENING**



PLUS screens, window shades, valances, upholstery, closet linings, shelf trimmings, wires, rug paddings, wire fencing, wall decorations — and many more

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And all leading Hardware, Home Center & Discount Department Stores everywhere.

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The Standard of Excellence
By Which All Others Are Judged.

LETTERS

FROM READERS

Overboard in cold water

Your item on the deadly effects of exposure to cold water (*All Outdoors*, page 30, March '75) is interesting and accurate. However, you didn't follow through. Canoeists, kayakers and surfers, for years now, have used the scuba diver's wet suit as a solution to this very problem. It's a very successful solution, as I can personally testify. I've been overboard in 38° F. water and never felt the slightest chill!

R.G. MARSTON
WILMINGTON, DEL.

Remove the plug

How To Get Your Power Mower Ready For the Season (page 111, March '75) was very informative. However, I detected an oversight regarding safety. While cleaning the underside of the blade housing, you should remove the sparkplug. Some manufacturers have a sparkplug wire clip mounted on the engine. However, the removal of the plug is a much safer practice. Also, the mower should be tipped with the carburetor facing up.

RONALD A. PEABODY
BATH, ME.

Have you ever smelled a buffalo?

In *Science Worldwide* (page 62, March '75) it is stated that the beefalo, a hybrid from a buffalo and a cow, was "first successfully bred in 1970 by a Californian."

Not so! As early as 1888, Charles J. (Buffalo) Jones started breeding the bulls of his buffalo herd with black Scottish Galloway cows. He called his hybrid the cattalo. He reported on his success in the *Farmer's Review* in 1888.

Mr. Jones, however, was not the only rancher to cross the buffalo and the cow. Col. Charles Goodnight, the operator of the legendary Goodnight Ranch in the Texas Panhandle, bred buffalo bulls with Angus cattle. He continued to cross-breed bulls and cows and cattalos and cows. A report of his successful hybridization is found in *The Journal of Heredity*, May 1914.

Mr. Goodnight called his hybrids the cattelow. The American Breeders, Assn., however, has employed the term "cattalo" as the official design-

nation of the buffalo-cattle hybrid.

All of this appears to mean that there is nothing new about your Californian's experiment but the name—"and what's in a name; a rose by any other name would smell as sweet." Have you ever smelled a buffalo?

Thanks for stimulating me to write this letter. I am obliged!

DR. R.B. STEWART
LEOTI, KAN.

Laminate tip

I wish to commend you on the article *How to Apply Plastic Laminate* (page 110, Feb. '75). I did my first work with such material about two years ago and many jobs since and was never able to find instructions for the beginner. Since then I have covered countertops, tables and many other projects.

There is a hint, however, I would like to pass on to others, not covered in most articles: To prevent the chipping problem when either sawing or routing, apply masking tape to both the top and bottom of the laminate, along the lines to be marked. This not only gives you a good surface to mark, but prevents chipping. In fact, it eliminates chipping.

HARRY H. JOLLY JR.
BURLINGTON, N.C.

Tells it like it is

Car Clinic is of great interest to me and I especially appreciate the way you "tell it like it is." This is most refreshing in a world where the truth appears to be something that is not polite to express in public. Keep on truckin'!

FRANK P. CONNELLY JR.
ARLINGTON, VA.

Shame on research!

Hopefully I'm not the only ear, nose and throat surgeon to cry "shame on your research department!" The very clever TV microscopy setup (*Now: TV Microscope for Surgery*, page 136, Feb. '75) is indeed a very forward, if expensive step. However, microsurgery was developed and perfected by ear surgeons a number of years ago and I dare say the largest amount of microsurgery is done by

(Please turn to page 10)

ONE DOLLAR!

announcing: The most incredible magazine subscription offer of all 10 weeks of **Moneysworth** authoritative, scintillating, wallet-fattening newspaper on a price that has inspired 2,000,000 devotees—for the crazy low price of **ONLY ONE DOLLAR!**

That's right, just pop a dollar bill in an envelope, with the coupon below, and we'll send you 10 weeks of inflation-defying, high-interest, hot-touch articles as:

12 1/2% on Your Savings
Travel at 50% Off
Jobs with Best Unemployment Pay
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Amazing new Two-Engine Car
by Soldiers Command High Pay
that Are Stingiest with Gas
Cost Insurance for Non-Smokers
Saving Accounts that Pay Interest
Prescriptions at Cut-Rate
Retirement Benefits Go Far
Mrs. Rockefeller Practices Thrift
"Yurt": Incredible \$350 House
for Dollars for the Middle Class
Sneeze at This Cold Remedy
Petite "Do-Good" Vacations
at 9¢ Pound
Bestsellers for the Price of 1
Pets the Jump with Its Rabbit
ing a Guitar You Won't Fret Over
ing the Best Locks
Timing the Cost of a Haircut
Meat Can Be a Real Value
the Checker Cab?
aware that Won't Go to Pot
Doctors Diet
neer Contagious? New Findings
Ways to Beat Sales Taxes
Nickel Phone Call Rises Again
Proof that Vitamin C Works
A.A.A. Is a Bad Trip
ing: Edible Newspaper
di's New Secret "Swiss" Banks
d's 100 Best Free Calendars
boats that Are Winners
aptors Belong in the Garbage
Jo's New Resort is a Wild One
Case for Shucking Off Claims
itutes Laid Low by Inflation
Peeling Is a Rip-Off
ine's Effect on Potency
rsweet News About Saccharine
evity Linked to Light Eating
well to Flatulence
ng: Staggered Tax Deadlines
a: Superfood for Man
receptive Foods
ing the Line on Phone Costs
Abzug's Nutball New \$2 Bill
inating Rating of Light Bulbs

In short, **Moneysworth** is a live wire sparking off hot information on the current money scene. It galvanizes readers all over the country into sending ardent letters like these:

• "The government has proven itself completely impotent in the fight against inflation. My only salvation comes from advice I find in **Moneysworth**. It save me as much as I lose through inflation."—*Theresa Ramseyer, San Francisco.*

• "Your article on the 15% interest paid by Mexican banks has made it possible for me to retire in style."—*Eric T. Svenson; Fallbrook, Calif.*

• "Thanks to **Moneysworth**, I am \$5,417 richer. I battled the Social Security Administration unsuccessfully for 18 months, then finally won out by following the advice of your article 'By All Means, Appeal'."—*S. Dominguez; Waterbury, Conn.*

• "Your article on air-fare 'triangular' routes was an astonishing. My wife and I saved \$100 each on a trip to New York by stopping off at Las Vegas as you suggested."—*H. Kesselman; Los Angeles.*

• "Boys, you are not going to believe this, but I have parlayed \$146 into \$90,000 thanks to your informative article on breaking into real estate."—*Horace T. Pinrose; Montgomery, Iowa.*

• "Your write-up on income averaging for tax purposes saved us \$1,100 this year. We didn't realize retirees could do this."—*Mr. & Mrs. J.W. Long; Morro Bay, Calif.*

• "We salute **Moneysworth** for its excellent report on our free sex-counseling-by-telephone service. As a result of it, we've received calls from all 50 of the United States—including Hawaii and Alaska—and even a few from Europe and Africa."—*Community Sex Information; Boston; (617) 232-2335.*

• "Your recommendation that readers reduce orthodontic bills by having the work done at a university dental school saved me \$1,350 on my daughter's teeth."—*Bob Walters; Oxon Hills, Md.*

• "Your tip on flying to Europe via Afghanistan saved me \$450. You've made me a subscriber for life."—*Charles B. Fager, M.D.; Harrisburg, Pa.*

• "Your advice on Social Security resulted in a \$3,135 lump-sum cash payment to my wife, and \$171 monthly pension. The best investment I ever made was a subscription to **Moneysworth**."—*Dr. Herman W. Hortop; La Grange, Ill.*

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funeral."—*R.J. Stevens, President, Continental Association of Funeral and Memorial Societies; Chicago.*

• "Your tip about deducting the cost of transportation between my two teaching jobs saved me in taxes at least the cost of a ten-year subscription. Not only that, but your publication is lively, off-beat, a delight to read."—*Professor Reuben Garner; State University College; Brockport, N.Y.*

• "Thanks to your article 'How to Buy a New Car for \$125 Over Dealer's Cost,' I just bought a Chevy at a saving that I estimate at \$350."—*Ron Bromert; Anita, Iowa.*

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• "Moneysworth's product ratings sure stretch the dollar. I bought the Canonet 35MM rangefinder camera you recommended, and saved 30%."—*R. Goodrich; Tucson, Ariz.*

• "Your article 'How to Fight a Traffic Ticket' saved me a \$200 lawyer's fee and a ticket."—*W.R. Wendel; Hicksville, N.Y.*

• "Your article 'How to Avoid Paying an Exorbitant Doctor Bill' saved me \$65."—*Carl Wagner; Yorktown Heights, N.Y.*

• "Your expose of charity rackets was a shocker. I've crossed several well-known organizations off my list, saving hundreds of dollars."—*Freida McMullin; Steelacoom, Wash.*

• "Your article on how to save \$100 on a color TV worked. Moneysworth sure knows how to hold onto the green."—*P. Allen; Dir. Student Union; Henderson College; Arkadelphia, Ark.*

• "Your article on 'coupon refunding' got my husband and me hooked on the hobby. It saves us enough each year to pay for our vacation."—*Grace Ellen Feingold; Brooklyn, N.Y.*

• "By ordering cigarettes from Wilson, N.C., as Moneysworth suggests, I have cut my smoking expenses in half."—*R. Paniewski; Chi.*

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• "Your article on TV game shows gave me confidence to try for 'The \$10,000 Pyramid.' I won \$850!"—*Ted Zammit; Franklin Square, N.Y.*

• "Your suggestion that I use a fake name in the phone directory, instead of paying \$1 per month for an unlisted number, alone pays for my Moneysworth subscription several times over."—*C.B. Russel; N.Y.C.*

• "Your report that dentures cost only \$40 at the Sexton-Shealy Dental Clinic of Florence, South Carolina, saved me hundreds of dollars. They fitted me up in 24 hours and I completed the entire procedure during a vacation to Florida."—*Mrs. H. Petruccio; Frackville, Pa.*

• "Moneysworth is aptly named. To paraphrase Churchill, 'Never have so many paid so little for so much'."—*D. Alpern; Pittsburgh, Pa.*

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LETTERS

(Continued from page 8)

ear surgeons. Need I say your article gives them no credit.

Other than that, I continue to be very pleased by your publication and look forward to my monthly issue.

HALSEY G. BULLEN, M.D.
STAMFORD, CONN.

Yes, they're really solar cells

Your February article *First Plug-In Solar Furnace for Your Home* (page 102) was quite informative. Someone at the University of Delaware surely wasted a lot of money if he really put cadmium sulfide cells on the roof of his house, though. They are photo-resistive rather than photo-voltaic, and dissipate power instead of generating power.

JAMES W. STUCKEY
BATON ROUGE, LA.

You're not the first to question the use of cadmium sulfide cells, but the university says: "When light strikes the solar panels on the roof, d.c. electricity is generated by the cadmium sulfide (CdS) solar cells." That quote is taken from literature published by Delaware on its project.

The use of air as a working fluid and stone as a storage medium has several attractive and practical advantages.

Mr. Keyes states in the article that "Water is a terrible storage medium, but rock is a very good medium; it gives up its heat slowly." The implication of such a statement could be misleading.

Using 30,000 B.T.U.H. as the heat loss for an average tight house in 30° to 35° F. weather, calculations show that it requires 36 tons of rock but only seven tons of water to store heat for a day. This equates to a 1700-gallon water tank, and the equivalent of a 6300-gallon tank full of rock. From a space standpoint, water is much more efficient by a factor approaching 4 to 1.

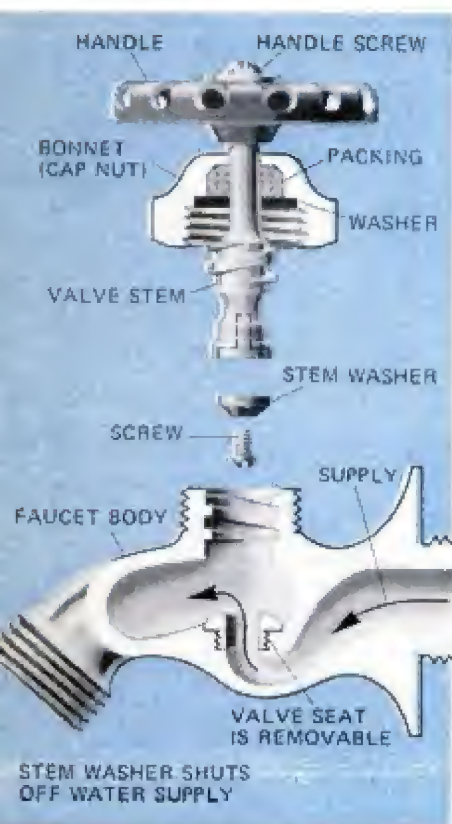
ROBERT ABRAMSON, P.E.
UPPER SADDLE RIVER, N.J.

Reports are not available

In *The Wind Shifts to Windmills* (page 80, Nov. '74) Brace Research Institute should not have been mentioned. Readers were referred to us for our publications list M17 and Technical report T43. Neither of these reports is available, and it has caused us great inconvenience, as we have received hundreds of requests for them.

T.A. LAWAND
MONTREAL

How to fix a dripping faucet



Types of leaks

A faucet leaks when turned off completely, chances are the cause of the problem is a worn stem washer. If dripping persists after you have replaced the washer, the problem is probably in the seat, the surface against which the stem washer presses to shut off water flow. Usually a rough, leaking seat can be corrected by dressing (grinding smooth). If dressing fails to stop a leak, the seat must be removed and replaced. If the problem is a leak around the stem—this kind of leak occurs when the faucet is turned on—it is generally a sign that the packing around the bonnet (cap nut) is worn and should be replaced. See page 12 for details on fixing leaks around the stem.

Before starting: shut off water

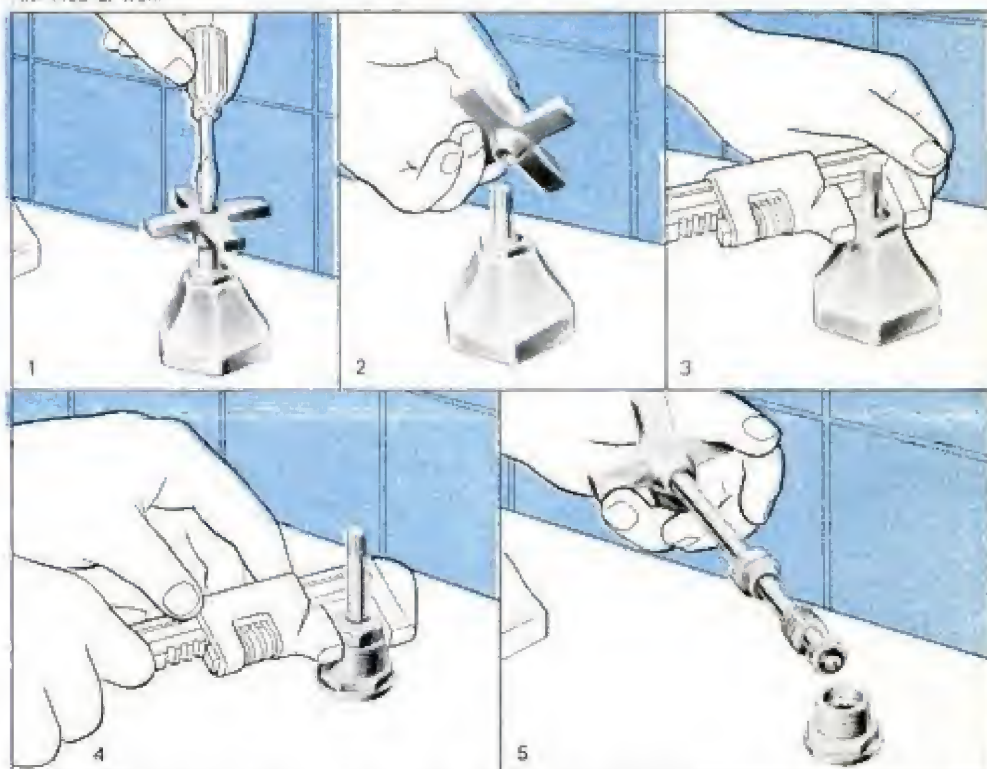
The very first thing to remember is that the water supply to the faucet to be repaired must be turned off. Ideally, and in most homes, the shutoff valves will be located in the riser pipes directly under the fixture. Both hot and cold-water valves must be turned off. With these valves closed, open both handles on the fixture to let water drain from the lines. If you do not have individual shutoffs on the risers, close the valve at the main house supply. When this is the case, and you are working in the basement or on a lower floor, the faucets on the floors above should also be opened.

There are three good reasons for fixing a faucet that drips: 1. The sound is annoying. 2. Constant dripping can stain a basin. 3. A dripping faucet costs money, since you pay for every drop of water that passes through your meter. (And a drop-per-second hot water drip means about 650 gallons per year—that you have also paid to heat.) Sooner or later, if a faucet is allowed to con-

tinue dripping, the water will discolor a sink through chemical action and abrasion, and you'll then be faced with the cost of replacing the sink.

Plumber's charges are high these days—a house call to replace a washer costs up to \$15. Changing a washer yourself need not be a frustrating experience. In fact, it's a simple and straightforward task if you follow the procedure shown.

Art. Fred L. Wolff



Removing valve stem and changing washer

Getting inside a faucet is merely a matter of removing parts in order, as they become visible. 1. The handle comes off first; it is usually fastened to the stem by a screw on top. Sometimes this screw is hidden by a decorative metal or plastic piece that must be pried off. After removing the screw, gently tap the handle upward while pulling with a rocking motion. Use the grip-end of a screwdriver to tap with. Then the handle can be lifted off the faucet stem.

2. On some faucets there may next be an escutcheon or housing that slips off, exposing the packing nut. On others, the packing nut may be next in line, or a separate nut to hold the escutcheon in place. In any case, the housing or bonnet must be removed. 3. Use an open-end wrench or an adjustable wrench with its serrated jaws taped to prevent marring the bonnet's finish. 4. Next the packing nut can be removed so the stem can be backed out. 5. Remove stem by un-

screwing. Here it may help to slip the handle back on temporarily. *Do not use pliers* on the top end of the stem—it's too easy to damage the fine splines that keep the handle in position. The washer is held to the stem with a small brass screw; loosen it while holding the stem by the handle or in a wood-padded vise (since the screwdriver blade can easily slip out of the soft brass slot).

Remove the worn washer and clean remnants away. Replace washer and screw, making sure the new washer is the exact size of the old. (These washers are made in a wide variety of sizes.) The valve stem, packing nut and other parts can now be replaced in reverse order of their removal. Before turning water on to test the repair, make certain all faucets are turned off, including those on floors above. If, after reassembly, the faucet still drips at the spout, the valve seat may have to be dressed to remove burrs and worn spots.

(Please turn to page 12)

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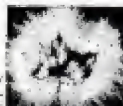
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Vacation home for \$129



A \$129 vacation home? Impossible? Not if you adjust your definitions of "home" and are willing to give up a few conveniences to be able to enjoy your previously vacant land. After all, home is any place you hang your hat, even if it is a commercially-made metal utility building.

Although we had the vacation homes of many friends and relatives available to us, our little chateau offered my wife and me, plus two toy poodles, the best opportunity of being near the building site of our future full-size home. And when that is completed, our first mountain home will revert to its original function as storage shed.

Our mini home had the mountains buzzing with curiosity. A few pessimists guardedly suggested that our place was not any worse than camping. But as an experienced tent camper since boyhood, I can safely say that our house beats a tent for many seasons. A good tent might cost as much, and it most certainly would not be as dry and cool. A tent would also not be as secure. Tools and possessions can be locked safely in our shelter. In addition, there is no problem if you arrive at your vacation and in the dark after a long drive during a pouring rain. And when it is time to leave, you just throw everything inside and slap on the padlock.

The ease with which it can be hauled to the site is another factor. We carried our vacation home 850 miles in the back of a Toyota Corona with a fold-down seat. One small, long box was carried on top. With this mobility, I had no worries about either delivery or availability of building materials. When I arrived, so had my home.

If I had built my first shelter out

of wood, I would have needed another man to help carry plywood, and would have had to make many more trips for the studding and other framing. I used a wood floor on block pilings (cost not included in the \$129 figure) because of the dampness of our river bottom location.

If you think 70 square feet will not be large enough for your needs, don't worry. The real secret is not size, but what you do with it. I designed a couch that folds to a 48x72-in. bed. Two foam cushions which are the bottom and back of the couch by day, become the bed at night. Underneath, there is approximately 18 cu. ft. of storage space. The basic arrangement of our dwelling is the kitchen on one side and the sleeping-sitting area on the other. This leaves plenty of room for moving around.

Our cooking facilities are a two-burner propane stove and a small toaster oven in which my wife baked biscuits, loaf cakes and blackberry cobblers. A small portable refrigerator is under the shelf-style kitchen counter, and a travel trailer sink with a simple trapless drain takes care of water drainage. The sink is important, because it is a lot easier for the cook to carry in water than it is for him or her to have to run outside every time something needs to be rinsed, or a little extra canned-food liquid gets in the way.

What about bathing and sanitation? Use your imagination. A sponge bath may not get you clean enough for the office, but it will do for mountaineers. And a portable toilet or outhouse isn't much to endure to be able to enjoy the Blue Ridge Mountains.

All in all, our little chateau may not be heaven, but spending the summer in the mountains is.

—Darrell Laremore

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IMPORTS AND MOTORSPORTS



Bank Rolls

For a motor car, the new \$75,000 Rolls Royce Camargue boasts something odd in the set of specs: "1.5 tons of refrigeration, approximately equal to 30 domestic refrigerators." That's the claimed cooling capacity. Now, we all know about British Thermal Units, but did you know that one ton of refrigeration is the amount of cooling produced by one U.S. ton of ice melting in 24 hours? That's one cold Rolls—and that's how many will be made per week until late '75



when production will be up to two. The first year's cars are already sold, many to Mid-East sheiks who won't need the oasis any more—not with the incredibly complex, automatic airconditioning system that has completely independent temperature control at upper and lower levels (you can warm your feet and still keep a cool head).

It's easy to treat lightly a car that's still a mirage (I haven't seen the Camargue yet, much less driven one!). The last time we were glib about Rolls Royce (*PM's Dockside Guide to Imported Cars*, page 82, Feb. '74) we got a quick response from a reader and Rolls owner who chastised us for our "cavalier treatment of the marque." Now we can

get away with it: The Camargue is the most "cavalier" of all the Rolls models on the road. Except for the traditional radiator there is nothing stuffy about the styling, which was done by Italian stylist, Pininfarina. The lines are quite rakish, in fact.

Overall length is 206.2 inches (or practically the same as the Seville, the new "international" size Cadillac); width is 75.5 inches; height, 58.0 inches and wheelbase is 120.1 inches. Mechanicals are shared with the Corniche: 6740-cc V8, four-wheel independent suspension, automatic ride-height control, four-wheel discs and so on.

Interestingly, Rolls sees the car as appealing to owners who prefer to drive themselves. The chauffeurs? Let them drive Corniches and Silver Shadows.

American graffiti

In California they just keep on trike-ing. This is the latest and maybe the smoothest. The single-seater TriVette is a three-wheeler with Fiat 850 running gear and fiberglass body that's legally registered as a motorcycle. It's good for 50 to 60 mpg, 100 mph and a couple of double takes per block. Bob Keyes, president of TriVette Corp., plans to



market it for \$4000 or \$2500 in kit form. You can write him at 2113C Palma Dr., Ventura, Calif. 93003.

Toyota's timid tease

The hatchback is the hottest thing since the self-starter. So how come Toyota only toys with this Celica Liftback GT for the U.S. market? Beats me. It was shown at the Chicago Auto Show "to measure consumer reaction to a Celica hatchback configuration," but there are "no current plans to sell the car in this country." I'd say every time a ship leaves Japanese ports with no Celica Liftbacks on board, Toyota is really missing the boat.



A good (year) idea

When motorsports are recognized as being as much a part of the American sports scene as those other pastimes—recognition that's long overdue—Goodyear will take its fair

GOODYEAR Motor Sports Club

share of the credit. The sport has needed a national perspective and that's what the Goodyear Motor Sports Club promises for fans and enthusiasts. There's a monthly newsletter, a quarterly magazine and other membership benefits to put you on the inside of the sport. Charter membership is \$10 (\$15 after May 31). For the full story write Goodyear Motor Sports Club, Box 428, Tarrytown, N.Y. 10591. Among the club's board of advisers is A.J. Foyt who took the checkered flag at the Ontario 500 in March. If A.J. does it at Indy this month, he'll be the only driver to win the Indy 500 four times. If you don't make the pilgrimage to the Speedway May 25, you can catch the race on the tube that evening. ★★

Rocker 'car pit' for your compact

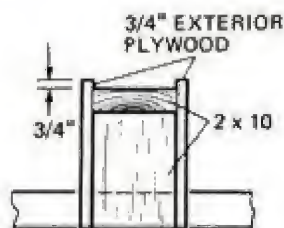
by Gene Rogers

Getting under my Barracuda to work on it is no problem when I drive up this "car-pit" ramp. I made it to rock like a teeter-totter so it will raise the car front or back by simply tipping it. First you wedge struts in place at the front, insert the front-wheel chocks, drive up the ramp until the wheels hit the chocks and set the handbrake. Then you remove the struts, tilt the ramp downhill and insert a second set of chocks. Your car is now safely "locked" on the ramp.

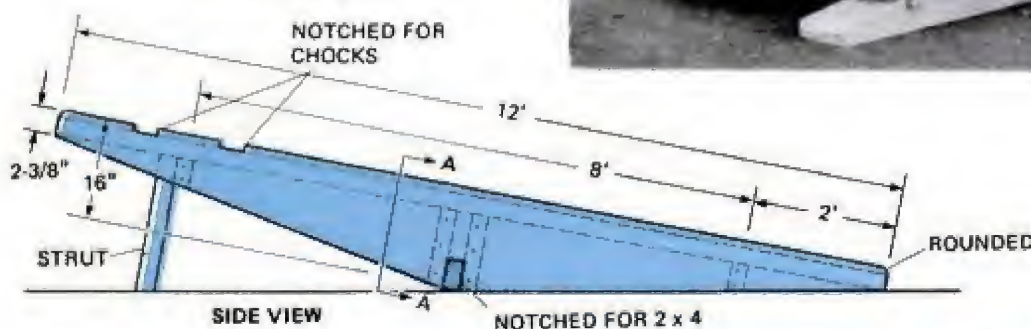
To raise the car front or back for headroom, you merely lift up on the bumpers. To gain full access to the underside of the car, you insert struts at each end of the ramp to support it level. The ramp can be dismantled for storing by using bolts to attach the 2x4 tiepiece. ★ ★ ★



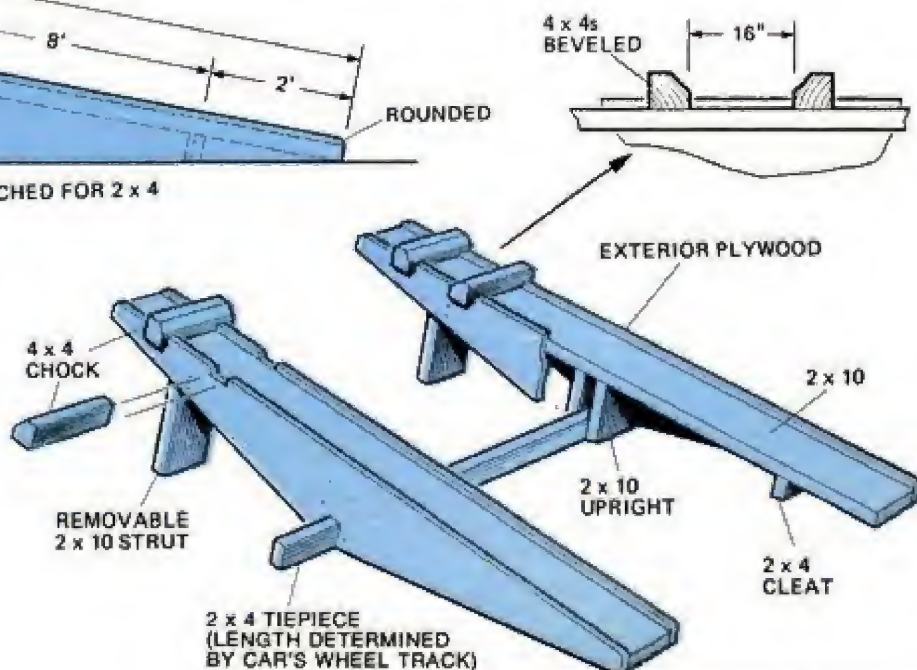
Rocker ramp will support car uphill, downhill or on level. Front-wheel chocks keep car from rolling, though for safety be sure to put it in gear and set the handbrake. The ramp will safely support compact cars weighing up to 3000 lbs.



SECTION A-A



Use a 12-ft. 2x10 plank for treadway of each "pontoon" and, with spacers placed between, add sides of exterior 3/4-in. plywood to produce girderlike beam. Use glue and screws. With economical cutting, you can get four sides from less than two 4x8 sheets. Each side is in two pieces, butted at the center to project 3/4 in. above the plank, then notched at the front ends to receive 4x4 wheel chocks 16 in. apart.

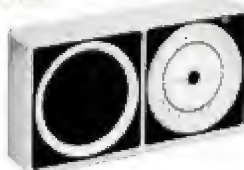


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Heathkit Digital Car Clock/Timer...62.95

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Heathkit Digital Alarm Clock...59.95

Electronic digits glow brightly to tell time to the second in 12 or 24 hour format. Electronic "beep" wakes you — with repeatable "snooze" switch. Black plastic cabinet with teak-finish vinyl decorator panels. Kit GC-1005, 4 lbs., mail.



Heathkit 3-in-1 Tuneup Meter...29.95

Checks dwell angle on 4-cycle, 3, 4, 6, or 8 cyl. engines with conventional ignition. Shows RPM to 4500. Measures voltages to 20VDC. Use with 6 or 12v. systems, pos. or neg. ground. Powered by engine under test. Kit CM-1073, 5 lbs., mail.



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Heathkit Fish Spotter® Sounder...69.95

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SCIENCE WORLDWIDE



New foam laps up water

Unlike conventional polyurethane foams, a new one on the market has an affinity for water, which makes it extremely versatile and easy to work with. Made by Grace Organic Chemicals, Cambridge, Mass., HYPOL is simply mixed with water (top photo) to produce a wide range of foams, from very soft to rigid.

The second photo shows how the foam acts like a wick, drawing water from one container to another. The Grace company claims that HYPOL foams will retain from 10 to 30 times their own weight of water, adding to their value as a flame-retardant material.

Possible applications for the new polyurethane include use as resilient floor and wall coverings, noise deadeners in automobiles, upholstery fabrics, and artificial sod.

High-octane crops

How much fuel does it take to produce an acre of cabbage? Answer: 76.7 gallons of gasoline and diesel fuel.

This was established by Cornell University researchers as the result of a study of energy needs for agricultural production in New York State.

The following estimates were given for other crops on a per-acre basis: onions, 61.6 gallons; potatoes, 51.3; sweet corn, 34.2; snapbeans, 29.2; apples, 44.4; and grapes, 39.5. Requirements estimated for farm animals on a per-animal basis were: milk cows, 54.4 gallons; beef cattle, 10.8; and laying hens, 0.5. Nationally, say the researchers, farm production consumes about 8 billion gallons of fuel, representing about 3 percent of the nation's fuel requirements.

Bike riding may strain wrists

Though a daily spin on your bike is recommended as a fine exercise for heart, lungs and legs, there's a danger you can get too much of a good thing.

A recent article in the *Journal of the American Medical Association* reports the cases of long-distance riders who showed weakness and atrophy of muscles in the hands, caused by damage to a nerve at the wrist. It's speculated that low-slung racing handlebars are a prime cause. Their position causes strong pressure to be exerted on the hands, wrists and forearms during each downstroke of the legs.

The riders all got better, the report states, after laying off cycling for a while.

Feed plants once a season

Fertilizers for "lazy" gardeners are a spin-off of microencapsulation technologies. A speck of fertilizer is encased in a thin plastic skin. When moisture from the air or soil contacts the capsule, a controlled amount of nutrient is released through microscopic pores.

Depending on how often a plant is watered, a single application of capsules reportedly will provide up to about four months worth of nutrients. Controlled release gives plants a steady supply of food and eliminates the possibility of burning.

New on the market are the "Precise" timed-release plant foods made by the 3M Co. The line includes spe-

cially formulated foods for vegetables, tomatoes, African violets and roses.

Sky-high solar collector

Citicorp Center, a 56-story skyscraper now under way in New York, may have a 20,000-square-foot solar energy collector on its roof, as is shown in the drawing. The plan will be car-



ried out if a study at the Massachusetts Institute of Technology shows it to be feasible.

Solar energy would be used to operate a dehumidifier in an air-conditioning unit, thus saving on the use of conventional fuels. Surplus solar heat would be used to supplement the heating of hot water for the building.

Now: No-scratch plastic lenses

Plastic lenses are popular with eyeglass wearers because they're so much lighter than glass lenses. But there's one drawback: They also scratch easily.

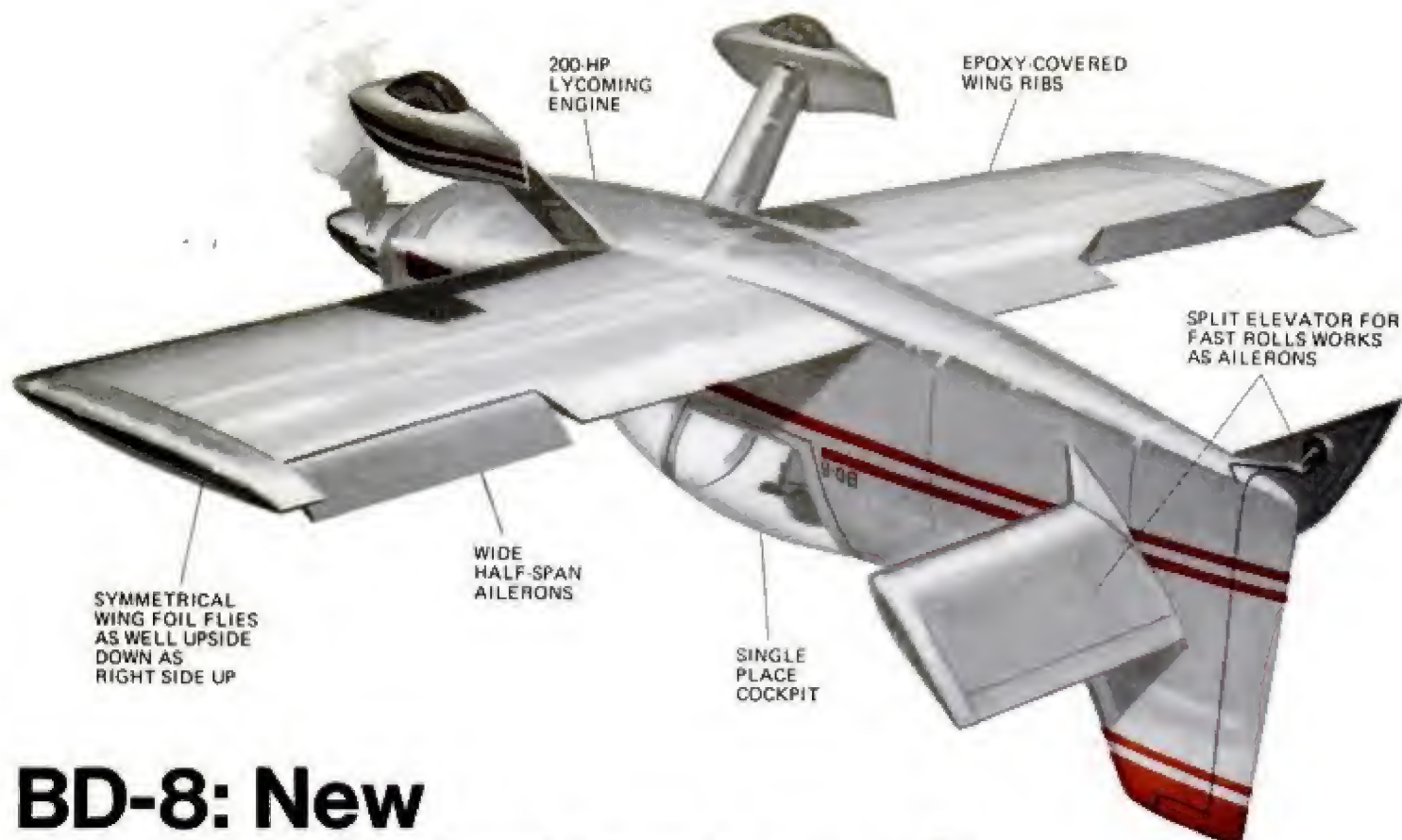
Now a Japanese optical company claims to have solved the problem through the use of a silicon and vinyl coating that's treated with irradiation from a cobalt-60 source. The lenses are said to meet all United States safety standards. ★ ★ ★

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OCT. '74.



BD-8: New super-aerobatic champ?

Famed aircraft builder Jim Bede is about to challenge the current record-holding Pitts Special with a ship designed to outfly anything around—and it just might.

by Sheldon M. Gallagher and Howard Levy

Photos: Howard Levy
Art: Roy Grinnell

She doesn't seem very glamorous, standing half-built in the gray gloom of hangar walls. And beside her flashy cousins—the sleek BD-5 and BD-5J jet—she's even a bit dumpy-looking. But don't let her plain-Jane appearance fool you—she might just become the wildest-flying airplane ever to take to the skies.

She's the BD-8—eighth and latest in a series of innovative aircraft to come from famed designer Jim Bede of Bede Aircraft, Inc., Newton Municipal Airport, Newton, Kans. 67114. Most of his earlier creations have been the ultimate in simplicity—good, basic, docile ships an amateur pilot could easily build and fly.

The BD-8 will be different. She won't be docile; she won't be simple. She's designed primarily for advanced competition aerobatics—the



most demanding flying there is. In addition to incredible structural strength, she incorporates one of the most complex and sophisticated control systems ever put on an aerobatic airplane. If she proves out as expected, she may fly the wings off anything else around—including, Bede hopes, the vaunted Pitts Special. For years, the little Pitts has been winning competition events all over the world and is the unquestioned current aerobatic champ. Bede would like to give the Special a run for her money and thinks his BD-8 can do just that.

Bede's optimism is based on a unique control arrangement designed to give the BD-8 vastly increased maneuverability. The elevator is split into two halves that can operate together or separately. Normally, they're locked together as a unit and function as a conventional elevator for climbing and diving. For aerobatics, they can be controlled differentially—one half pivoting one way, the other the opposite way—like ailerons. Their similarity to ailerons produces exactly the effect Bede is after.

His reasoning behind the novel *(Please turn to page 24)*

Partially completed fuselage is shown at top left. At center is the split elevator—secret of ship's added roll control. Cockpit (bottom) appears to have no control stick, but it's side-handle type, barely visible at right.



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BD-8: AEROBATIC CHAMP?

(Continued from page 22)

concept is intriguing. As a plane slows down in certain aerobatic maneuvers—as in a vertical climb or when approaching the top of a loop—airflow over the wings is reduced and the ailerons become progressively less effective. But this doesn't happen to the elevator because it's in a direct line with the backwash from the prop. Thus there's always a strong rush of air over the tail no matter how fast the plane itself is traveling. By splitting the elevator, Bede has, in effect, added an extra pair of ailerons that continue to function after the conventional wingtip ailerons lose control.

With this split tail, Bede can spin his ship like a top, rotating it in its own prop wash, even when it's virtually at a dead standstill stall. In snap rolls, vertical climbing rolls and other maneuvers with fast, tight turns, results should be spectacular. The ship will also be fitted with sail-plane-type spoilers—another innovation—for precise control over speed and sink-rate characteristics. Bede counts on tricks like these to win championships.

In appearance and construction, the two competitors couldn't be more

different. The nostalgic Pitts is a classic open-cockpit, wood-and-fabric biplane straight out of the barnstorming era. The modern BD-8 is a shiny metal-and-fiberglass low-wing, canopy-enclosed monoplane somewhat resembling a midget racer. In performance, however, the rivals are pretty closely matched. The BD-8 is powered by a 200-hp Lycoming, giving it a slight edge in speed—260 mph max, compared to the Pitts' 176 mph on 180 hp. But the Pitts does a bit better on rate of climb—2600 feet per minute against a projected 2500 f.p.m. for the BD-8. Both have excellent power-loading factors—important in aerobatics: 5.45 pounds per horsepower for the BD-8, 6 pounds for the Pitts. Both are also fairly close in weight—1150 pounds gross for the Pitts; the BD-8 a little lighter at 1090 gross.

Like the Pitts, the BD-8 is small—only 14½ feet long with a wingspan of 18½ feet. Its rated stress limits are a phenomenal 12 Gs positive and 12 Gs negative, with an ultimate (brief-load) maximum of plus or minus 18 Gs! This is fantastic when you consider that the FAA minimum stress requirements for safe aerobatics are a relatively mild 9 Gs positive and only 4 Gs negative. One reason for the BD-8's colos-

sal strength lies in a huge 6½-inch-diameter tubular steel spar that runs through the fuselage from wingtip to wingtip—Bede is making sure nothing pulls the wings off this baby!

Despite her hot performance, the BD-8 is still a safe, easy handler for the nonprofessional pilot. Stall speed is a low 49 mph, and she can land and take off in 500 feet. One thing old-time pilots may find strange is the absence of a centered control stick. Instead, the controller is a small handle located on the right-hand side of the cockpit—a system now used on military fighters and also adapted for the BD-5 series. Moving the handle forward and back raises and lowers the elevator as a unit for normal use. Hitting a release instantly unlatches the two halves and couples them to the aileron control for differential operation in aerobatics.

At present, marketing plans for the BD-8 are indefinite. If Bede follows his custom, it may be sold as a kit for do-it-yourself assembly, as are others in the BD series. But there's good reason to believe Bede will first want to get his rare bird into the hands of some crack professional aerobatic champs—and in that event, watch out. Some wild things may begin to happen. ★ ★ ★

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"Not all the time, but, you never know...anything can happen. Once, when I was in the army...coming back across the country...my old car was so loaded down that the shocks went out. I mean...it was flat! I was in this little town...and I had to come up with extra money to cover it. So I used BankAmericard. It saved me."

Do you ever use your card when there's not an emergency?

"Sure. Let's say I find a pair of shoes on sale and I'm between pay checks. I get the shoes with BankAmericard, and then, when the bill comes, I can take care of it."

What about the cost of the card?

"It didn't cost me anything to get it.* It works the same as a store card. Only I can use it where I want to."

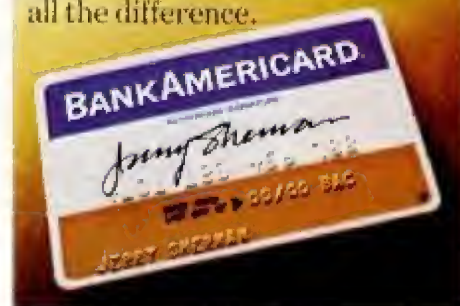
What happens if you lose it?

"Nothing, if I contact the bank before somebody uses it. Even if somebody's already run up a bill of...say \$600 on it, the most I'm liable for is \$50... if that."

How do you feel about having BankAmericard?

"I'm careful with it. I don't use it all the time. But there've been times when if I hadn't had the card, I'd have really been out of luck. It's a good thing to have."

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You never have to use it when you don't want to. But sometimes just having it makes all the difference.



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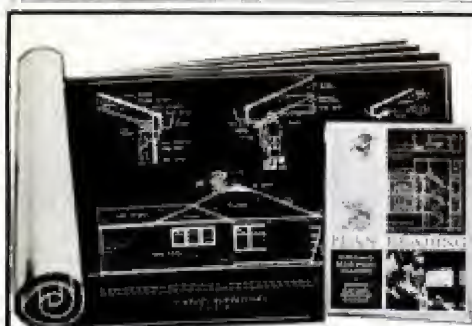
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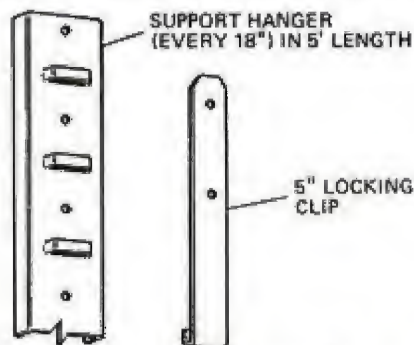
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Siding system is claimed to be one-third faster than conventional way to apply siding.

Speedier siding installation



Locking clip is inserted through nearest slot on support hanger (top photo); then, after clip is engaged in siding lip, it is pulled taut and bent down to secure.

A new approach to installing aluminum, vinyl and steel siding is now on the market. Claimed to be easier and faster than conventional nail-application of siding, the system was developed with the do-it-yourselfer in mind.

First, the substrate is prepared (in the photo above it is with foil-faced vapor barrier stapled over clapboard siding), then preformed metal support hangers are nailed up approximately 18 in. on center. For an even appearance, all nails are driven through the hangers on the old siding's high points (butt edges of clapboard).

Next, at each hanger, a metal locking clip is slid under the new siding's lip and inserted through the appropriate slot in the support hanger. Hanger slots are spaced about 1½ in. apart along the full 5-ft. length of each support hanger. Thus there is always a convenient slot best suited to the strip of siding being applied. After the clip is inserted, it is bent and folded down to obtain a positive holding action; the following siding course conceals the hardware. At the top, where siding meets soffit, holes are drilled along the top edge of the last course and the siding is nailed. Molding is then applied to the joint to conceal nailheads.

The manufacturer claims the system is better than the overall nailing method because the siding is permitted to "float": Siding can expand and contract with changes in temperature without any buckling.

Designed for use over wood shakes, asbestos shingles and masonry as well as clapboard, Lok-Tite System is sold through lumberyards and building materials suppliers. For nearest dealers, write to Mak-Rite Inc., 125 Blackford Ave., Middlesex, N.J. 08846.

—Harry Wicks, Workshop Editor

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BY MORT SCHULTZ

CAR CLINIC

200 miles per quart

My friend has a 1973 GMC Sierra Grande ¾-ton pickup, with a 454-cu.-in. engine and automatic transmission. It uses one quart of oil every 200 miles. The engine was rebuilt at 4000 miles and again at 11,000 miles with new sets of piston rings and valve stem seals. After work was done, oil consumption decreased to about one quart every 400 miles, but it has now returned to a quart every 200 miles. Work was done by a reputable GM dealer, who referred the problem to the area service manager. According to this representative, "We now feel that satisfactory repairs were performed and lubricating oil consumption for this engine is normal." Could this be true?—Ron Smith, Puyallup, Wash.

No, GMC advises that "200 miles per quart of oil is not normal" and the high consumption indicates "something is wrong with the particular engine that has not been corrected." The company will contact you, and you can refer its representative to your friend.

Several possibilities for this abnormal consumption exist:

1. Overfilling. The engine oil level should be verified at the FULL mark on the dipstick with four quarts of oil in the engine and with the engine warm.

2. An external oil leak that has gone unnoticed.

3. Oil passage by the intake valve stems. Because of its size and power, the 454-cu.-in. engine under light-load conditions runs with a higher manifold vacuum than smaller engines. Intake-valve guide oil sealing is more critical with high-manifold vacuum. Possibly the dealer didn't install the newest kind of valve seals that have double-spring retainers and ridges to help the engine retain oil. Made by Perfect Circle, they carry GMC part No. 352698 and entered production during the 1974 model year.

4. Oil passage by piston rings because of improper ring seating. If so, a properly done bore job and new rings should be the answer.

Topsy-turvy

The rear split-glass window of my 1968 Mustang convertible is coming

apart at the seams. Is there any adhesive I can use to repair the vinyl rubber between the glasses and also the fabric to the glass?—Ronald H. King, Yorktown, Ind.

Sorry, but no, there isn't. Your only choice, other than to maintain the status quo, is to have a commercial auto top and upholstery shop install a new isinglass window.

Saving space and face

If it isn't used, how long is the canister of the Space Saver spare tire in my 1974 Pontiac Ventura good for? I would hate to be on a back road at night, have a flat and find the canister empty.—S.A. Morrell, Piedmont, S. C.

Go with confidence. Canisters are likely to leak immediately or not at all. Shaking a canister will tell you if it's retaining its contents. Full, it "shakes" like any full aerosol can. According to General Motors, "The specified leak rate allows a full leak-down to take a minimum of 10 years." If you're still dubious, your Pontiac dealer has a device that will tell if your canister is leaking.

Big head

I admit I'm proud of myself, but maybe my experience will help fortify the confidence of others and help them save money, so here goes:

The car is a 1970 Dodge Dart with 225-cu.-in. engine and Holley 1920 carburetor. The problem is an engine that suddenly stalled and upon being restarted would idle so rapidly that it was necessary to keep my right foot on the accelerator and my left foot on the brake so I could drive in traffic. No amount of fast-idle screw adjustment, even way beyond the specified setting, would return the idle to normal.

I checked the fuel-pump delivery by disconnecting the fuel line at the carburetor and cranking the engine, letting gas flow into a jar. Although I didn't have any fancy delivery meters, I decided that delivery was normal, because it looked okay. At the same time, I was able to examine fuel to see if it was contaminated with water or dirt. It wasn't.

So I carefully disassembled and inspected the carburetor, paying special attention to the float unit. I

found everything in order until I removed the main jet from the metering block, and there I found the trouble—a small dab of sludge on the tip of the jet. I carefully touched this with a toothpick, and it came out easily.

Since I don't have compressed air, I cleaned parts by pouring gasoline over them—something I wouldn't advise be done except with extreme care and outdoors. I reassembled everything and started the engine. It ran perfectly, and it has been running that way ever since. Of course, I wouldn't suggest checking behind the main carburetor jet whenever an engine stalls, but I thought you'd like to know to what lengths an "unprofessional" can go to save his auto dollar in this day of recession-inflation bind.—Gene St. Pierre, Pasadena, Md.

It takes patience and scrutiny, Gene, but you are right. Many car owners are scared away from jobs they can do themselves because they look too tough. Your experience should help allay some fears. Thanks.

Smoky Subaru

My 1974 Subaru sucks oil into the air cleaner from breather hoses leading to valve covers. This seems to clog the air filter and also causes occasional clouds of blue smoke from the tailpipe. The dealer tells me this is no problem—"They all do it," but it doesn't seem right. Any solution?—Dan Avery, Cataldo, Idaho.

No, Dan—no solution. Oil accumulates in the air cleaner because this is the way the emission-control system functions. For this reason Subaru recommends air-cleaner service every 3000 miles. You may hear of a crankcase relief ventilation kit offered by an independent company that's supposed to alleviate the condition, but its use is not recommended because it may upset the emission balance.

Headlight hijinks

The headlights of my 1973 Chevrolet Monte Carlo work only at times. I'll turn them on, and they will work. I'll turn them off, but when I go to turn them on again, they won't work. Dash and parking lights function at

(Please turn to page 32)

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CAR CLINIC

(Continued from page 30)

all times. I have replaced the on-off switch, and checked the headlight ground connections, fuse connections and master plug. No relief. I'm skittish about going anywhere at night for fear of getting stuck in the dark. Help.—Larry W. Bruce, Portland, Ore.

I'll bet you didn't check the dimmer switch, because I suspect it is the source of your trouble. It may have a loose connection causing a break in the circuit, and thus intermittent operation, or the switch itself may be malfunctioning. So remove the switch from the floorboard for tightening of connections or replacement.

To hounds, again

I own a 1974 Audi Fox plagued by

squealing brakes, so I read with interest your comment regarding new brake pads in the Oct. '74 Car Clinic. My dealer knows nothing about this. The Porsche-Audi regional representative tells us the company is "working on the problem," but no corrective modifications have been found yet. No one knows anything about new brake pads. Can you give me additional information?

—Chester R. Hoatson, Bethesda, Md.

Sure. Tell everyone to order part No. 823698151A. Are they in for a surprise!

SERVICE TIPS

■ **Chrysler Corp.** reports you can use radial-ply tires on a Valiant or Dart if you have a recently issued front-sway-bar kit (part No. 3879243) installed.

■ **Ford Motor Co.** has issued an advisory concerning synthetic motor oil. Any oil

that meets Ford specification ESE-M2C101-C "is acceptable for use in Ford Motor cars and trucks." Warranty coverage will not be affected if the oil meets this specification and oil-change intervals in vehicle owner's manuals are followed. However, in an obvious reference to manufacturers of synthetic oil it is stressed that "It is the responsibility of the manufacturer or marketer of the engine oil to insure that his product meets our specification."

■ **Chevrolet** advises owners of 1975 Monte Carlos not to tamper with routing of the battery's positive cable. Correct routing of cable is *through* the loop formed by the fuel feed and vapor return line. ★ ★ ★

GOT A PROBLEM WITH YOUR CAR?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be published in the column.

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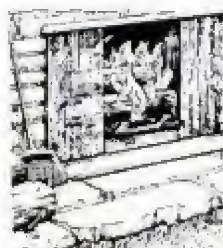
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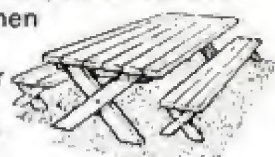
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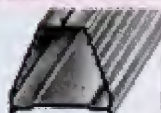
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PHOTO HINTS

FROM READERS



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Easy chest pod

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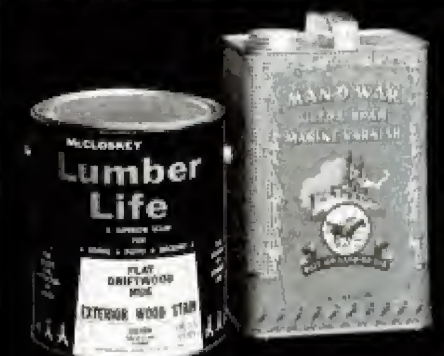
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HOMEOWNERS' CLINIC

Put torch to fireplace?

You have advised what seems to me a rather laborious, messy method of cleaning soot from inside a natural fireplace (Homeowners' Clinic, page 20, Dec. '74). Although I've never tried it, wouldn't the use of a propane torch be much simpler, faster and more effective?—Teen Beckstead, Hayward, Calif.

Please accept my special thanks for raising the question. Using a torch would seem simpler, faster and more effective—except for the fire hazard. This isn't to say that it can't be done, but there is real danger of starting a chimney fire, which would be most difficult to control in a natural fireplace with a soot-coated flue. For this same reason, I've hesitated to suggest using a newspaper torch to aid in inducing a draft in a cold natural-fireplace flue—the same hazard exists. Even in chimneys in good repair, the heat of a soot fire is of dangerous intensity; stick to the elbow grease instead of taking chances.

How much insulation?

I have 3-in. insulating batts in my attic, and I'm told I can reduce heating costs by adding more before next heating season. But no one I've consulted agrees on how much additional insulation or what kind I need. Can you advise?—M.L. Gordon, Saginaw, Mich.

Assuming that the existing insulating batts are between attic-floor joists and not between the roof rafters, I think you might add 3½-in. batts of the unfaced R-11 type, as generally specified. This is usually enough insulation for attics that are tight—with no appreciable leaks of warm air from below, as from poorly fitted access trapdoors or fold-up stairs. With blown-in types of insulating material, you could increase depth to 7 or even 8 in., but this depth is not normally justified, except possibly in a more extreme climate.

Smaller, not weaker

If I plant miniature or dwarf roses this spring, will they live through the next winter in this climate? I'm told they will—and also that they won't. Who's right?—J. Edwardson, Carbondale, Ill.

Your "will-live" advisors should be right. Dwarf, or miniature, roses are normally hardy if cared for properly during the growing season. Supply them with adequate water and plant food, and protect them from winter kill just as you would the other varieties.

One-way lamp

Please tell me how to make my three-way lamp light three ways. Heretofore it's worked okay. But now the new bulb lights only once, on the second click of the switch. I did notice that the old bulb seemed to catch, did not turn out freely.—Mrs. Ted Willis, Tacoma, Wash.

In turning out the old bulb, you may have bent or otherwise damaged the center contact in the socket. First, disconnect the lamp cord from the outlet. Then remove the bulb and examine the center contact in the socket. If it is bent out of position or twisted, straighten it with pliers or a screwdriver and bend it back to the central position. The contact is delicate—be careful not to break it. Reassembled, the lamp should again light properly, on all three power levels.

Lagscrew those steps

My basement stair treads are loose and even large nails no longer hold them, although the stringers seem to be strong, showing no sign of rotting. How can I anchor the treads so they no longer tilt and squeak?—Roger Smyth, Lansing, Mich.

Lagscrews will usually hold where nails won't. Drill and counterbore for ¼ or 5/16-in. lagscrews at the center of each tread, making sure that the pilot holes are undersize so that the screw threads will take snugly. Use a suitable washer on each screw. Draw the screws down tight but not too tight, or you may strip the thread they cut in the wood. ★★★

Do you have a home maintenance or repair problem? Send it to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in this column. For more home repair and maintenance help, get PM's Home Care Guide, \$4.45 postpaid. Send orders to PM, Dept. HE5, Box 1014, New York, N.Y. 10019.

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Toro's electric mower: Cordless, quiet, compact

Electric mowers have long been appealing for their easy starting and quiet operation, but until recently you had to drag around a long power cord and hope you wouldn't slice through it. Now battery-powered cordless rotaries are here—and handy. One of the latest is Toro's 16-inch, 55-pound, sleekly designed "Carefree Electric." Besides its soft purr, it's loaded with convenience and safety features: You can plug it in for overnight recharging without removing the battery. Its folding handle permits compact storage. Cutting height is adjustable to four positions. A squeeze switch on the handle must be held closed to keep it running; let go and it instantly stops. It also must be started with a key switch to make it kidproof. A deflector shield blocks any debris the blade kicks out.

What you don't get with a cordless, of course, is self-propulsion (to



Flip-up cover permits recharging without removing battery from the machine. Motor (right), smaller than coffee can, is surprisingly powerful, spins blade 3350 rpm.

conserve power)—it's strictly a push-it-yourself deal. Cutting capacity is 45 minutes per charge—enough for a lawn 70 by 100 feet. That's pretty good—ideal for small, fairly level yards. Price, including charger, is about \$170 (bagger optional). All in all, we tried it and liked it. Toro Co., 8111 Lyndale Ave. S., Minneapolis, Minn. 55420.

—Jim Liston and Dick Dempewolf.



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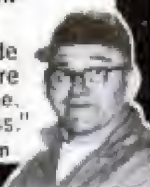
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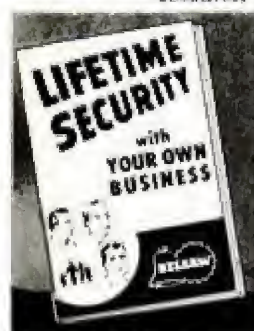
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AMC PACER

The first wide small car.



Bell & Howell Schools announces two ways to learn new skills in electronics without ever going to class or giving up your job!

Pick the one

Here are two fascinating home-learning adventures that say, "Don't envy the man with skills in electronics...become one!"

If you had to drop everything and go off to school to learn new skills in electronics, there's a chance you might not do it. But Bell & Howell Schools' excellent home training has already proved to tens of thousands that you don't have to drop anything...except the idea that classrooms are the only place you can learn!

You can keep your job, your paycheck and your way of life while you're learning. Because these programs allow you to pick the training schedule that best fits in with your other activities. It's *that* convenient.

I. AUDIO/ELECTRONICS

The first learn-at-home program including 4-channel technology. Explore this totally unique sound of the 70's as you experiment with testing equipment and build a sound center featuring Bell & Howell's superb quadraphonic equipment!†

Learn about 4-channel sound—without a doubt the most impressive technical advancement in sound realism in years. A development by which separately-recorded channels literally wrap a room in sound.

And now, for the first time, you can also discover this latest achievement in audio electronics with a fascinating learn-at-home program that explores the whole area of audio technology including 4-channel sound reproduction. A program that could lead you in exciting new directions with professional skills and technical know-how.

You actually build and experiment with Bell & Howell's high-performance 4-channel audio center...including amplifier and FM, FM-Stereo tuner.

Understanding today's audio technology requires practical experience with high caliber equipment. And with the Bell & Howell amplifier and tuner, you've got the technological tools you need to gain the knowledge and skills that could open up opportunities for



you in the audio field. Of course, we cannot offer assurance of income opportunities.

The sophisticated amplifier gives you the circuitry you need to conduct the comprehensive experiments necessary to master audio technology. Like signal tracing low level circuits, troubleshooting high power amplifier stages, and checking the operation of tone control circuits.

You'll investigate the technology behind this amplifier's full logic, 4-channel decoder and learn how full logic decoding produces outstanding front to back separation.

The tuner you build has both superior performance specs and state-of-the-art features such as: all solid state, FET front end for superior sensitivity, crystal IF filters for wide bandwidth, and a superior stereo multiplex circuit for excellent stereo separation.

You cover the full range of electronic fundamentals.

But make no mistake. This learn-at-home program is not just about 4-channel sound. It covers the full range of electronic fundamentals leading to understanding audio technology. So when you finish, you'll have the occupational skills to become a full-service technician, with the ability to work on the full range of audio equipment such as tape recorders, cassette players, FM antennas, and commercial sound systems. Get complete information on this unique program by checking the appropriate box on the card—mail it today!

† Cabinets and speakers available at extra cost.



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Simulated TV picture/test pattern.

II. HOME ENTERTAINMENT ELECTRONICS

Gain new skills in Home Entertainment Electronics in an unusual learn-at-home program that includes the new generation color TV you build yourself!

This is the first program of its kind to include the study of digital electronics. And what better or more exciting way to learn about it than to actually build and test a 25" diagonal color TV employing digital electronics?

You'll probe into the digital technology behind all electronic tuning and channel numbers that appear on the screen. An on-screen digital clock that shows the time to the second. You'll also gain a better understanding of the exceptional color clarity of the Black Matrix picture tube, as well as a working knowledge of "state-of-the-art" integrated circuitry and the 100% solid-state chassis.

As you build this remarkable, new generation color TV, you'll not only learn how advanced integrated circuitry works, but how to detect and troubleshoot problems in any area.

Sound good? Then mail the postage-paid card today for more details.

Whichever program you choose, you'll get to build and experiment with your own electronics laboratory.

"Hands on" working experience with the latest equipment is the key to Bell & Howell Schools' home training. That's why in both programs we start you off with a set of equipment called the Lab Starter Kit, including a fully-assembled volt-ohm meter designed to help you experiment with and better understand basic electronic principles. So you don't just read about electronic principles, you actually make them work!

Next, in step-by-step fashion, you'll assemble Bell & Howell's exclusive



Electro-Lab® electronics training system. It includes a special design console that enables you to assemble test circuits. A digital multimeter for accurately measuring voltage, current and resistance. And a solid-state "triggered sweep" oscilloscope which will allow you to analyze the functioning of tiny integrated circuits. Putting these instruments together will give you experience in wiring, soldering and assembling. Then, further on, you'll use the lab equipment for experience in electronic testing, troubleshooting and circuit analyzing.

We try to give more personal attention than other learn-at-home programs.

Both of these programs are designed so that you can proceed through them smoothly, step by step. However, should you ever run into a rough spot, we'll be there to help. While many schools make you mail in your questions, we have a Toll-Free Phone-In Assistance Service for questions that can't wait. Bell & Howell Schools also holds In-Person "Help Sessions" in 50 major cities at



various times throughout the year. There you can talk shop with your instructors and fellow students and receive additional assistance.

Get details on one or both of Bell & Howell Schools' home-learning adventures...

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Taken for vocational purposes, these programs are approved by the state approval agency for Veterans' Benefits.

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DETROIT LISTENING POST



BY ROBERT LUND

The small Cadillac is here

The Cadillac Motor Car Div. of General Motors has let the Cad out of the bag at last. See page 105 for our test drive of the new Seville.

New Fours from GM and Ford

GM and Ford are developing new four-cylinder engines that can be used as "switch-hitters." Switch-hitters because they could be used either in existing small cars or in smaller-yet cars planned for '77 and '78. The Ford product may be out in a '76 car.

More Pacers on the way

It will be three to four years before GM and Ford come up with cars to compete with American Motors' Pacer—smaller on the outside, roomier on the inside. Smaller cars coming from the Big Two next year and in 1977 will be scaled down in total package. That means less room on the inside, unlike Pacer which has as much interior room as most intermediates. The GM and Ford Pacer-type cars will not be ready before 1979 or 1980.

Meanwhile, AMC is working on a four-door Pacer. But four-door what? Car, wagon or both?

Army seeking dual-fuel cars

Can an automobile engine be designed to operate on more than one type of fuel—gasoline plus another fuel that does not have a petroleum base—without making mechanical modification of the engine in switching from one fuel to the other? It's an intriguing concept and at least one "automaker" is experimenting with the idea. That is the Army, which has a vehicle research and development center in Warren, Mich., just outside Detroit. The Army has placed contracts with suppliers to develop dual-fuel engines for military vehicles.

Toss-up: plastic or steel?

Carmakers are confronted with a six-of-one, half-a-dozen of another situation on whether to use steel or plastic for bumpers. Most current cars use steel, although GM produces a few cars with plastic bumpers. The government has decided the steel

bumper capable of absorbing a 5-mph impact without damage isn't worth the price. The government is talking about reducing the impact protection to 2.5 mph and specifying plastic. This presents problems.

The price of plastic has gone up so much in recent months that it costs as much or more than steel. The car buyer would pay more money for less protection. The redeeming feature of plastic is that it weighs less than steel. Engineers estimate they could save something like 85 to 100 pounds by going to plastic. Less weight means better gas mileage. The mathematics get pretty involved. Would the car owner save enough on gas to offset a price increase on the car to pay for the plastic bumper? An inferior bumper at that? The right hand gives and the left hand takes away.

Leaner look for Ford lines

Speaking of saving weight, Ford hopes to bring the average weight of its cars down to 3000 to 3500 pounds by 1980. That would be 1500 pounds less than today's 4500 to 5000-pounders. Where Ford's goal is to trim 1500 pounds over five years, GM's target is to lose 1000 pounds over three years.

Chrysler's rust fighter

One of the most worthwhile improvements on Chrysler's '76 cars will be hidden away where you can't see it. The company is experimenting with a process that paints and rustproofs in one operation. At this stage, the process can only be used on concealed parts because the finish coat isn't very attractive to the eye.

Bargains still abound on '75s

Don't feel bad if you missed out on buying a new automobile when the car companies were pushing their cash rebate programs. You will still be able to get a good deal on a '75 car the rest of this model year.

Most automakers and most dealers will continue to offer some sort of discount-off-list-price incentive to get you to sign for a new car during the rest of the model run. They may not use the word rebate, but that's what it will amount to.

Although the auto companies have worked their way out from under the massive inventories of unsold cars they carried last winter, Detroit isn't out of the woods yet. There are still a lot of parts and subassemblies that were produced before the cutbacks in car production. Some of the parts can be used on the '76 cars, but much of the material can't be carried over except for replacement purposes. It has to be used on the '75s.

This is one reason automakers are talking about bringing out the '76 cars later than usual. So if you want a '75, there will be plenty of time to shop for a bargain between now and the new models.

Fat cars, fat prices

The auto companies are running scared as a result of the decline in car sales and that may not be all bad. Detroit is being forced to do some original thinking about how cars are priced. This could mean a break—lower prices—for a lot of people in future years.

Cars used to sell for about \$1 a pound. They now sell for something like \$1.80 to \$2 a pound. But you don't get a break on the per-pound price if you buy a Pinto or Vega instead of a Lincoln or Cadillac. Hamburger or New York strip, you still pay the same on a per-pound basis.

Some Detroit thinkers suggest this arrangement should be changed. The fat cars should carry fatter prices and the smaller cars should carry smaller prices. Something like the progressive income tax—the higher your income, the higher your tax.

Would this approach kill the big, luxury cars? Would everybody want a small, light car? High prices haven't hurt the luxury cars so far. The '75 models of the big cars are selling at about the same rate as last year, without rebates, despite the high cost of gasoline, despite tight money for financing a car, despite high maintenance costs.

Automobile dealers say it's easier to sell a \$12,000 Eldorado or Mark IV than it is to sell a \$3500 Vega or Pinto. However, Detroit wants to turn that around, increase sales of the bread-and-butter cars, and a change in the per-pound price may be the way to do it. ★★★

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Kings, 16 mg. "tar," 1.1 mg. nicotine; Longs, 17 mg. "tar," 1.2 mg. nicotine, av. per cigarette. FTC Report Oct. '74

ALL OUTDOORS

WITH BILL McKEOWN



Film facts

Everyone already has his mind pretty well made up about hunting, but anyone who is willing to look at both sides of a question will get a great deal from the new film called *A Question of Hunting*. Produced without any product plugs by Larry Madison Productions at the request and sponsorship of Remington Arms, it's about as straightforward as you can get in stating why some people just hate the sport and others like it very much.

Carefully researched and strikingly photographed, it shows how, as the country expands and open ranges for wild animals diminish, we can either do something about wildlife management or do nothing, deplore the results, and simply hope for the best.

The 28-minute film is available free from Modern Talking Picture Service, 2323 New Hyde Park Rd., New Hyde Park, N.Y. 11040, for showings by groups and TV stations. Anyone willing to test prejudices against documented facts may find he owes Remington a vote of thanks.

In time for next year's Bicentennial, a new movie from Mercury Motors called *Harbors of America* features historic and picturesque ports along the eastern seaboard. It is available on free loan from Telefilm Ltd., Box 709, Homosassa Springs, Fla. 32647.

Railroads revisited

When Teddy Roosevelt and other great sportsmen of 70 years ago set off for an outing in the wilds, they headed there by train. The luggage racks and baggage car could handle almost any amount of duffel you wanted to bring along, from favorite saddle to oversize fishing rods. No complications if your gun cases packed a brace of shotguns, carbine and pearl-handled six-shooters—but just don't try casually carrying those firearms and bulky gear aboard any scheduled airline today.

Flying is certainly the fast way to travel now with minimum gear, but we decided recently to try a test-run again over the rails. Amtrak had been advertising its "no-strain trip by train." When we needed to get from New York to southern Florida

with a lot of equipment early this spring for boat-testing reports, this seemed like a good time for comparison with car travel (about three days), bus (about 29 hours), or flying (two and a half hours). The train takes around 25 hours or more. Coach fare of about \$100 in a plane is approximately \$30 more than the train, \$40 above a bus one way.

Today's train travel, it turns out, is well suited to today's self-sufficient outdoorsman. The knapsack with your camera, toilet kit and towel can also hold rations and candy bars for emergencies when the lounge car runs out of sandwiches—a regular occurrence, we learned. It also helps when three hours gets too long to wait in line for the dining car, though one hour is more likely. Also, carry a bag's worth of small change; the trainmen don't, and would rather keep the difference. Credit cards are supposed to be welcome in the dining car but, like so many places now that advertise them, are not.

If the heating system breaks, you can make good use of your down jacket or sleeping bag; if the air-conditioning gives up as it sometimes does, the windows won't open but at least you don't get coated with the soot of old-time locomotives. Yet a long trip can be less tiresome and

faster than driving your own car, and Amtrak has arrangements to reserve a car at discount on arrival.

Consider today's train travel as a somewhat restful but adventurous way to go with a lot of gear along and you won't be disappointed.

Best badges

After completing work for the 10 merit badges that are required, the next three subjects that were most popular with Boy Scouts last year as voluntary selections were Home Repairs, Canoeing and Fishing. Recent Scout records show over 50,000 fishing badges awarded in a year, and a growth rate of about 20 percent in fishing's popularity among the 123 merit badge skills and arts available.

Better water

With cities, towns, housing developments, vacation homes, industries, farms, Navy ships and commercial vessels all fouling up our waters, it was only natural, perhaps, that recreational boating should be chosen as an easy target for blame. Strict recent rulings outlawed the use of flow-through marine toilets on pleasure boats, and all craft with a "head" installed had to have a holding tank and, hopefully, some place to pump it out.

Now, it appears, the Coast Guard and the Federal Environmental Protection Agency have come to more reasonable conclusions. Approved flow-through treatment devices, as an alternative, apparently will finally be accepted. That seems to mean that pleasure boats that now have flow-through heads have an option of installing treatment devices or holding tanks over the next three years, and new boats being constructed may also have a choice.

Effluent treatment devices have been found to be so efficient that, in a few years, our polluted waters will have to be blamed on more basic causes.

Black-powder bonus

Another example of correcting onerous legislation came several months ago when laws were revised to allow muzzle-loader fans to purchase up

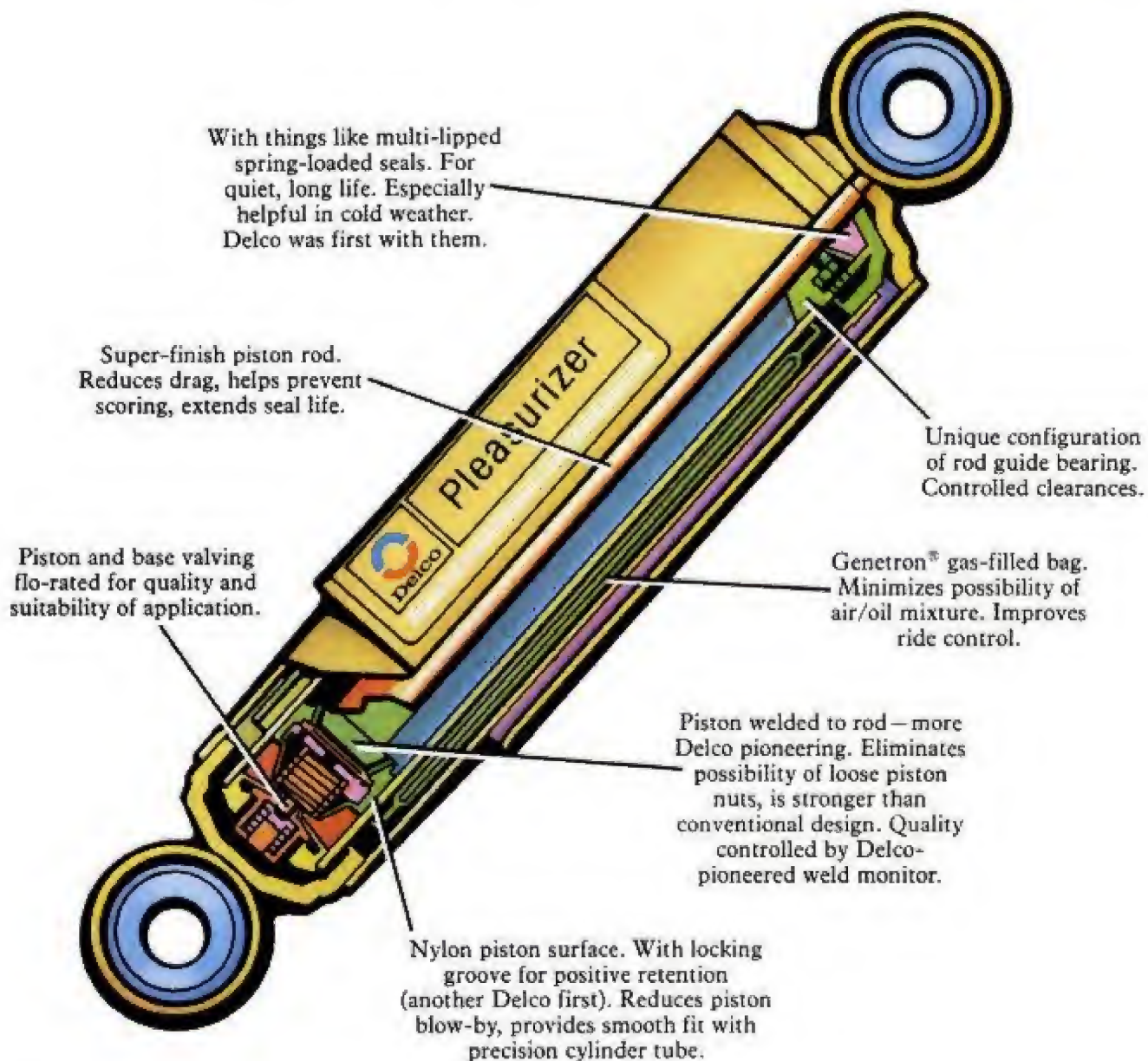


Waterproof backpack of rigid plastic, Rec-Pac from Anzen Products can be adapted for canoeing, cycling, picnicking and for carrying diving or photographic equipment. Price is about \$30.

(Please turn to page 54)

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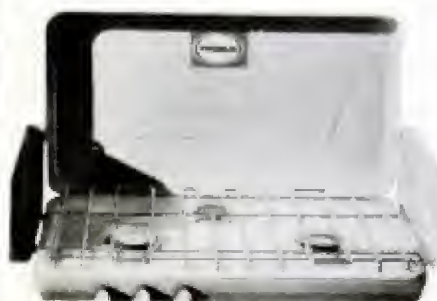
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ALL OUTDOORS

(Continued from page 52)

to 50 pounds of commercially produced black powder, instead of five. The new law still restricts purchases to legitimate users engaged in sporting, recreational or cultural purposes, and does not change the strict criminal penalties for misuse of explosives, including black powder and igniters.

Apparently there had been fear that black powder might be used to make bombs, though no one in his right mind would construct explosives and, even then, wouldn't use black powder. Statistics show only an insignificant number of recorded bombings have involved black powder as an ingredient.

Over half a million enthusiasts are now collecting and shooting antique and replica muzzle-loading rifles and cannon. First of the National Muzzle Loading Rifle Assn. events at Friendship, Ind., will be held May 14 to 18, and the big midsummer meet that brings shooters and spectators from all parts of the country comes Aug. 16 to 24. With the rapid growth of the sport, 39 states now permit black-powder hunting as well.

Fish finder fiction

Sportsmen have noticed that some states seem to go out of their way to pass needless, uninformed or absurd legislation. Minnesota, the state that created the model law for sensible regulation of snowmobiles, now seems to be trying for the how-to-harass fishermen award. Last year a bill was proposed to ban all electronic sonar fish finders in the state on the grounds that they gave fishermen an unfair advantage over fish. After that one was laughed out of the

legislature, a new one has been introduced to outlaw all units with a graph printout on a chart instead of the flashing light.

The assumption apparently is that if you see a mark you think is a fish on your chart, the fish will automatically find your lure, like it, feel like eating it, and bite it. The proposed bill would ban the use of finders by sportsmen but not commercial fishermen.

John Uldrich, of Vexilar depth and fish finders, noted recently that sonar instruments can help a fisherman locate fish but, so far, cannot be programmed to make a sportsman take anything that's more than the legal limit of his catch.

New laws against electronics may not be the way to protect the old lunkers.

Best in books

The boat that can go anywhere is the dream of any number of sailors. Some even locate one that might do the trick and learn the hard way about the various punishments the sea can inflict. But Capt. Robert Beebe, after retiring from the Navy, set out to find boat designs and methods that could make ocean voyages practical and even comfortable for a moderate-sized powerboat today. Since the launching of his 50-foot Passagemaker in 1963, his success and travels with his "flopper-stopper" antiroll rigs have become famous.

And now he tells us how it's done. *Voyaging Under Power*, just published by Seven Seas Press, 32 Union Square, New York, N.Y. 10003, is one of the few books destined from the start to be a how-to classic of the sea. With a foreword by Carleton

(Please turn to page 56)



Standard in the outdoor field, the 75-year-old Coleman Co. receives a plaque from 73-year-old Popular Mechanics. Left to right: Outdoors editor Bill McKeown,

Coleman president Larry Jones, chairman Sheldon Coleman holding PM award, Coleman vice president Frank Shaw with latest of his company's camping lanterns.



Why it pays to shop at The Insurance Store.

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ALL OUTDOORS

(Continued from page 54)

Mitchell, famous sailor turned famous powerboat skipper, the volume is available at \$12.50 from bookstores or \$12.90 postpaid from the publisher.

For covering a boat, repairing a boat or building one from fiberglass, the most explicit instructions available are in *How To Fiberglass Boats* by Ken Hankinson, \$5.95, from Glen-L Marine Designs, Bellflower, Calif.

Two more for the outdoorsman's bookshelf are *The Getting Game*, by PM contributor George Daniels, \$6.95, published by Harper & Row, and *The Great Escape*, \$7, a catalog-type publication from Bantam Books. Though Daniels' tips can be used by anyone who likes to find something for almost nothing, his explanations of how to acquire a boat or a vacation house gratis should especially please sports types. *The Great Escape* includes information about how to get started in hang gliding or houseboating, how to go down the Amazon by canoe and get college



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credits for it, or where to find wild African animals to hunt in Texas. Out of thousands of suggestions for various outdoor sports, a few may especially appeal and nearly all make intriguing reading.

New worthwhile free booklets and catalogs are available in which we've found much helpful information along with the ads. *A Shooter's Guide*, by Weaver Scopes, and *Jeep's Four-Wheel-Drive Comparison Book* are both available from dealers. From the Council on International Educational Exchange (CIEE), 777 U.N. Plaza, New York, N.Y. 10017, is the new *Student Travel Catalog* with money-saving angles, trips and discounts for anyone connected with the educational community. And *Sheldon's 1975 Fisherman's Guide* 50 cents from Shep Shepherd, Box 1075, Antigo, Wis. 54409, is free if you mention this column. ★ ★ ★

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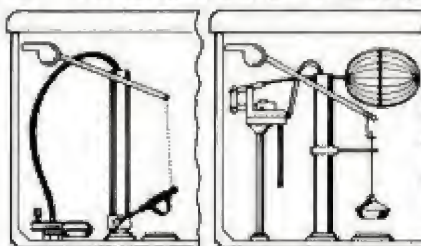
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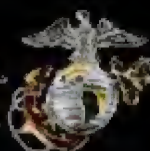
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APPLIANCE CLINIC

BY PAUL MANN



Freezing points

The water line to the icemaker in our Westinghouse refrigerator freezes although the water is always left running. Every time an ice jam occurs and I call a serviceman, it costs me \$18. Is there a better way?—Paul G. Miraglia, Glendora, N.J.

There is—but exactly what it is depends on where the line is freezing, since the problem could be occurring either in the line itself or at the water line spout.

Water could be freezing in the line where it passes through the freezing compartment. If this is the case, you may be able to solve the problem by wrapping the water line with insulating tape (from your hardware store). The other place where an ice jam can develop is at the spout where water is ejected into the pickup pan. Westinghouse has had a problem with its so-called carousel icemaker, and has issued a heater kit that clips to the spout to keep water from freezing. You can get it from a Westinghouse dealer; it includes complete instructions, and installing it is no big deal.

Burning off

One unit of our Hotpoint electric range (catalog No. 307RF456) burns a wire off at the connection every six months. I have tried asbestos-covered wire one and two sizes larger, but it didn't help. Any solution?—L.J. Rateliff, Jackson, Miss.

Clean the Calrod terminal thoroughly with steel wool, and then solder the lead to it. This may help. If the wire burns anyway, then I would replace the Calrod. The problem, I think, is that the Calrod terminal and wire are not making good contact, maybe because of looseness or a carbon buildup on the terminal. In any case, arcing is happening, and this is what's burning the wire.

Going unfrostless

We purchased a frostless freezer without knowing how much electricity it uses. The unit is a Sears Cold-spot. Since the price of electricity is outrageous, we would like to know if we can disconnect the heater that makes the unit frostfree. We were told that if we could do this, we

could reduce our electric bill substantially.—P.L. Girvin, York, Pa.

You can disconnect the heater—but it may not get you anywhere. You then would have to defrost the freezer manually every three or four days. This unit is effective because an airflow is kept unimpeded by regular defrosting. If the evaporator builds up frost, airflow and freezing capability are affected.

Even if you would do this frequent manual defrosting, there's another obstacle. The evaporator is not readily visible, and the only way to be sure that all frost is removed is by playing a stream of hot air over the grille concealing the evaporator. You can use a portable hair dryer to produce the air stream—and it will take twice as much electricity as the freezer's defrost heater. The heater consumes only 500 to 600 w. and runs twice a day for 15 to 20 minutes. You might call your electric company for the monthly cost of this heater. You may conclude that converting to manual operation isn't worth it.

But if you still want to disconnect the heater, unplug the freezer and find the timer, up front behind a grille on the left-hand side. Remove the two ¼-in. hex-head screws and slide the timer out carefully. Disconnect the No. 2 lead to the timer—it's probably orange. Tape the end of the wire and that's it.

Wet clothes

Our Kenmore automatic clothes washer does a great job, but for one problem: After it spin dries, clothes come out soaking wet and have to be wrung out. Water seems to drain from the tub okay. What's wrong?—Alfred Santos, Brooklyn N.Y.

A user mistake or one of several mechanical conditions can make clothes retain water. The user mistake is a tendency to overload the machine and use too much detergent. If you are not doing this, then begin the mechanical diagnosis by checking the drain for a restriction that may be keeping water from being discharged fast enough. Check that the washer is level—an out-of-balance machine can leave clothes wet. The last possibility is a drive basket clutch that has lost spring tension, which must be between definite limits

(18 to 24 in.-lbs.) to provide an adequate spin. Consult a serviceman if the other possible causes are absent.

Drill jolt

While I was using my Shopmate ¼-in. drill to countersink a ⅛-in. hole in soft brass about ¼-in. thick, the bit bound for a second and an electrical flash about as big as your hand appeared at the bit's end. The house fuse didn't blow, and the drill worked after that. But hair on the back of my hand was singed. Two electricians I asked can't tell me what happened, and I'm afraid to use the drill. Can you help?—Wilfred M. Churchett, Amsterdam, N.Y.

The drill is shorting out, under load only, from the motor through the gear train and into the chuck. Since your drill is probably made of aluminum and not double-insulated, you became the ground. The drill should be tested in a shop on a hi-pot to see if this is happening. The hi-pot, a high-voltage tester that puts 1000 v. into the tool with its switch locked on, can tell you if there is a complete circuit from the line cord through the motor housing with the tool under load, or if there's a short.

Unclipped

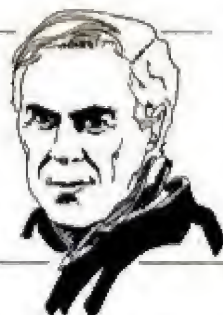
The spring clip that holds the plastic grille to the frame of our General Electric 6500-B.T.U. air conditioner has broken off. We were told by a serviceman that the item cannot be repaired, and we would have to buy a new grille, which costs \$40. Is there an alternative?—Mrs. L. Schwartz, Flushing, N.Y.

Replacement clips are made for some GE grilles. Without seeing your grille, I can't tell whether clips would be available. I suggest you take your grille to the manager of a nearby GE parts center; there's one on Northern Blvd. in Long Island City. If he says the grille won't accept a replacement clip, you could try to glue the broken clip in place with an epoxy cement. ★ ★ ★

If you have a question about any appliance, send it to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N. Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

THE BICYCLE SHOP

BY EUGENE A. SLOANE



You can build a light-weight, high-performance tricycle with a conversion kit and almost any old two-wheeler—even a tandem. Trike shown weighs just 36½ pounds.



Many readers of this column have asked about adult tricycles for people with balance problems, or for those who wish to ride safely over slippery roads and frozen lakes. Once you master it, a tricycle is definitely more stable and less tippy than a two-wheeler. Even if you have never learned to ride a bicycle, you can learn to ride a three-wheeler quickly and safely.

Trouble with commercial trikes is they cost a bundle, upwards of \$198, and weigh around 85 pounds (except for Schwinn's at 45 pounds). Some have rather bad brakes and are cumbersome and hard to pedal. It's easy to make your own tricycle at half the cost of a factory-made machine, and half the weight of most. All you need is an old two-wheel bike you can convert (and convert back quickly, if desired), mechanical ability to build Tinker Toys and about \$85 for a conversion kit and parts.

You can build the trike as a five-speed, or 10-speed or fixed-gear model. I urge you to stick to the fixed-gear type, first because pedals always turn with the wheels (no freewheeling) and you can help stop the tricycle by backpedaling. This not only adds safety, but you can also back out of a parking place at the supermarket, maneuver in tighter quarters and amaze traffic at stoplights. Second, with the fixed-gear version you do away with derailleurs, shift levers and cables, cutting weight and making the trike a lot easier to maintain. You can select a gear ratio that will get you over most hills, although this compromise won't let you set any speed records. Here's what you'll need for the conversion:

Conversion unit includes: Rear axles, housing, bearings, hubs and stays. Cost, about \$65, from Wheel Goods, Inc., 14525 21st Ave. N., Minneapolis, Minn. 55441, or from manufacturer Ken B. Rogers, 71 Berkley Ave., Cranford, Houslow, Middlesex, TW4 6LF, England. If you order from Wheel Goods you eliminate the hassle of customs clearance.

Fixed-gear cog and locking ring screws onto gear holder that is in turn fitted to a hex-shaped shank on the conversion unit (with fixed gear). Select a rear cog to give a gear ratio of around 1.25 to 1 or 1.45 to 1, using your smallest front chainwheel. Figure gear ratio by dividing number of teeth in front chainwheel by number of teeth in rear cog. If you want about a 1.45 to 1 ratio and have a chainwheel with 40 teeth, you would use a rear cog with 28 teeth, which gives you $40/28 = 1.43$, or a 1.43 to 1 gear ratio. Fixed-gear cogs are for racing, so most are ½ in. wide, which fits ½-in.-wide coaster-brake and three-speed bike chains. It will not fit 3/32-in.-wide derailleur chains. If you can't find a 3/32-in. cog, grind down a ½-in. cog, but do it slowly and don't overheat the cog, which would destroy the hardness given it by heat-treating.

Two rims. Order the same rim size as your front wheel. You'll need to lace up wheels because the conversion unit comes with hubs only. These have 36 holes, so you'll need rims with 36 holes. Rim width as well as diameter should be the same as your front wheel's.

One tire and tube. Use same size as front-wheel tire. Use tire and tube taken from the old rear wheel on the other trike wheel.

Spokes. You'll need 72—36 per wheel. Use 12¼-in. spokes for 27-in. wheels, 11¼-in. spokes for 26-in. wheels. Spoke diameter should be no greater than .082 in. (2.1 mm) to avoid having to drill out hub holes.

Thinner spokes will have play in holes and may break prematurely.

A 5/16 x 2½-in. seat-post bolt and nut is used to hold conversion stays.

Three or four extra chain links will be needed if you convert to a five or 10-speed trike. (I do not recommend converting a coaster-brake or three-speed bike to a five or 10-speed trike. You would have to grind down or replace the ½-in. chainwheel to accept the 3/32-in. derailleur chain.) Use same make as old chain.

Caliper brake, cable and brake lever are needed only if you are converting a coaster-brake bike that has no front caliper brake but does have a fork crown with room to drill a hole for the brake mounting bolt; such a hole may exist if the fender is mounted.

Here are steps in converting to a fixed-gear tricycle:

Step 1: From old bike, remove rear wheel chain, rear fender and brake, derailleur and cables, shift levers, guide tunnel, rear-brake cable, rear tire and tube.



Step 2: Install fixed-gear cog on conversion unit, tighten lock ring firmly so backpedaling won't unscrew it. Install conversion unit in dropout slots. Use spacers to align rear cog with chainwheel. Tighten dropout bolts enough to hold unit in place. Photo shows how unit fits.

Step 3: Insert conversion-unit stays into clamps on axle housing and into seat-post bolt. Tighten clamps and bolt enough to hold.

Step 4: Lace and true new rims on hubs. Cross spokes four. For lacing and truing instructions, see March and April '73 *Bicycle Shop* or page 433 of my book, *The New Complete Book of Bicycling*, \$12.50, Simon & Schuster, Inc. Install tire and tube on each wheel. Install wheels,

(Please turn to page 64)



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THE BICYCLE SHOP

(Continued from page 62)

squared ends of hubs first, on axles; tighten wheel nuts firmly.

Step 5: Place tricycle on level floor. Put spirit level on top tube, adjust rear wheels to level tube.

Step 6: Install chain. If original bike was five or 10-speed, you'll have to remove three or four links. Chain should have no more than ½-in. droop (gravity deflection). Move conversion unit back in dropout slots for correct tension.

Step 7: If you have no front brake (you must have one since there's none at the rear), install front caliper brake, cable and brake lever. Drill hole in fork crown or use fender hole. Adjust brake so shoes are about ⅓ in. from rim when brake is open. True front wheel if necessary.

For five or 10-speed conversion:

Step 1: Remove parts as in fixed-gear conversion, Step 1, except derailleur parts. Remove five-speed cog from rear wheel.

Step 2: Install five-speed freewheel cog on conversion unit. Install unit as for



fixed-gear, but align freewheel cluster third gear between the two front chainwheels (or on single chainwheel of five-speed). Install wheels, tires.

Step 3: Install chain, adding or removing links to get the correct chain length, so



that, on 10-speed, the derailleur body is about parallel to chain, with chain on two largest gears (photo); on five-speed, chain length is right when derailleur body is vertical, with chain on largest rear gear.

Step 4: Same as fixed-gear trike, Step 5.

Now you're ready to ride. Strangely, experienced cyclists have the most trouble because they try to steer by balance—it only helps the trike go its own way. Practice on a sidewalk, but beware a sloping driveway. The trike will try to turn into the street; more than one cyclist has found himself in traffic because he was afraid to *steer*. Don't let the trike steer you, and remember, balance *away from*, not into, turns. ★ ★ ★



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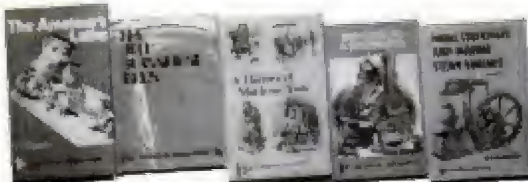
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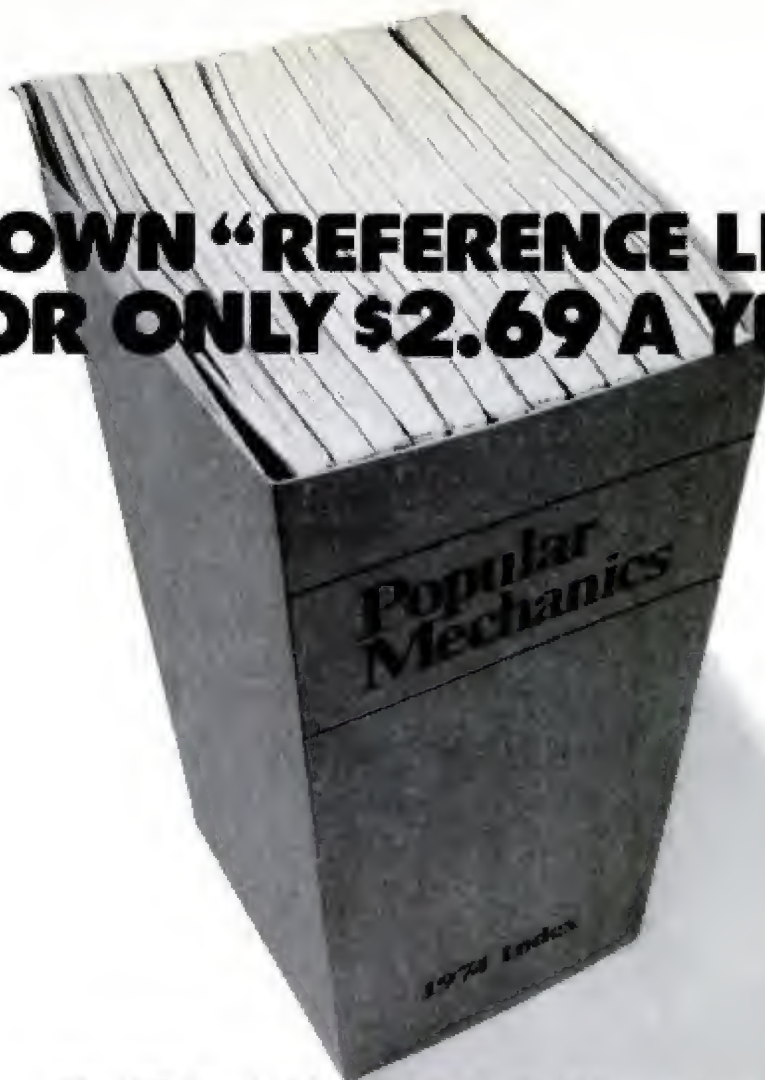


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A 'new' Suez Canal shapes up for 1980s

In a decade, say Egyptian officials, the old waterway will even carry supertankers.

by John Pearson and Ken Anderson

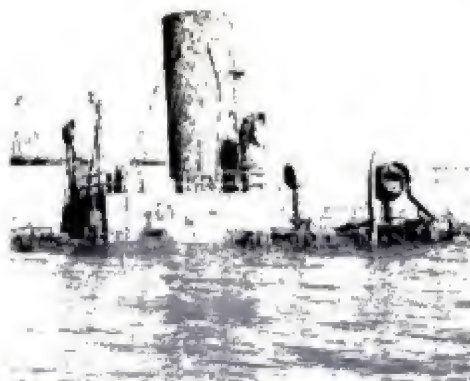
In November, 1974, four Egyptian ships slowly made their way from Port Said down to Suez—the first commercial ships to enter the Suez Canal since it was closed by mines and scuttled ships in the Six-Day War of 1967. The event didn't cause much of a stir in world shipping circles, for it had been years since the canal functioned as the vital artery between Europe and the oil-rich Middle East.

The canal had been made largely obsolete by a new class of ship—the supertanker—a development of the mid '50s. Even though they have to sail around the southern tip of Africa to carry oil from the East, tankers of 200,000 and 300,000 tons can do it much more cheaply than a smaller ship of, say, 50,000 tons, taking the shorter route through the Suez Canal.

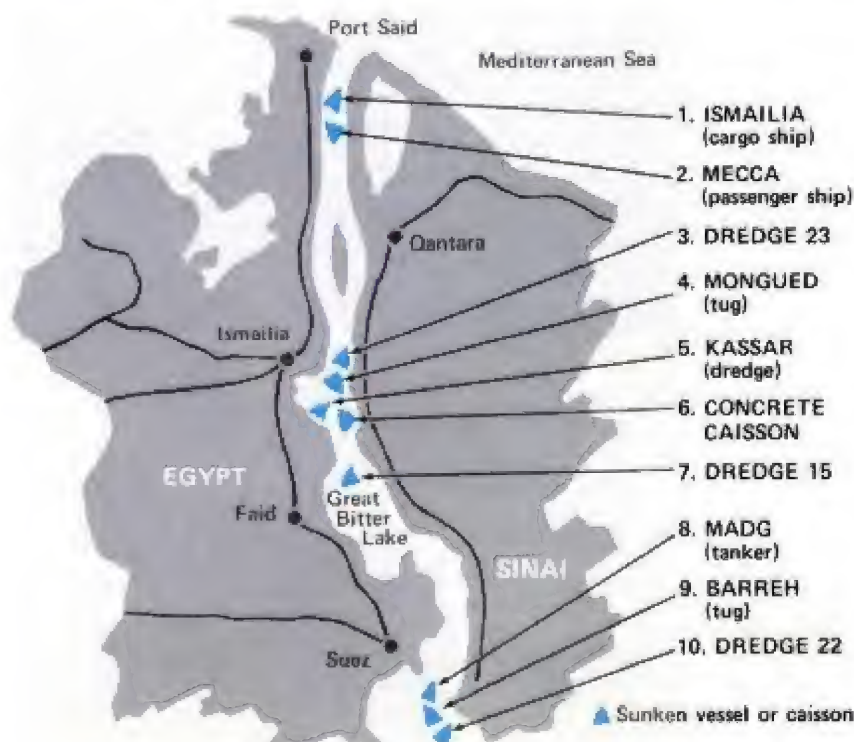
But now the Egyptians hope to come to terms with the supertanker. They have announced plans for a vast project in which the canal would be widened and deepened, making the average cross section four times the present size. This would allow supertankers of up to 260,000 tons to pass through.

The new project will cost over \$1 billion and will require the excavation of an estimated 1036-million cubic yards of silt, sand and rock—more than double the volume that had to be moved in building the entire Panama Canal.

But rebuilding the canal is only part of an overall Egyptian plan to modernize the area. The project also includes two new jetports and at least two industrial-commercial complexes along the banks of the canal. A tourist center is to be established at Ismailia, about midway between



Barnacled stern section of tanker *Madg* juts above water after ship section was dumped near shore by salvors. Below: Two self-propelled cranes lift section of *Mecca* prior to dropping it on canal bank.





the Red Sea and the Mediterranean, and five highway tunnels are to be built under the canal at various points between Port Said and Suez City to expedite commercial wheeled traffic between the industrial and business centers on each bank of the waterway.

The idea of a canal through the desert wasteland between the Red Sea and the Mediterranean may be as old as Egypt itself. One of the most ancient archeological treasures ever found in those desert sands,

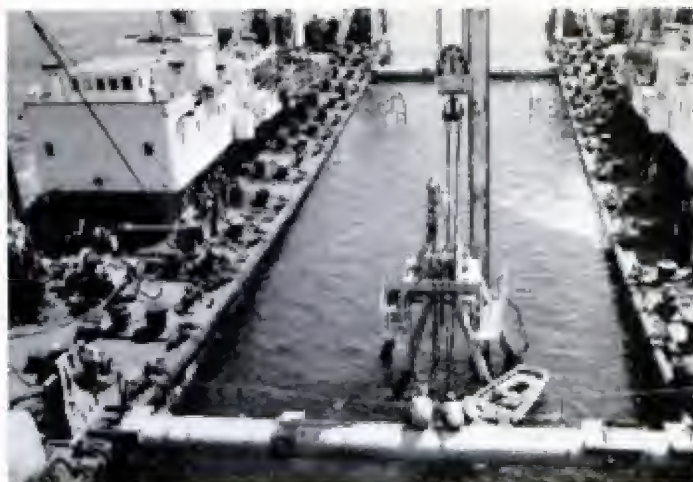
a mace head nearly 6000 years old, bears a carving that portrays workmen finishing the banks of a canal. Priests of the earliest Egyptian dynasties recorded tales of a great canal that existed even earlier.

Among the better documented records of Egyptian history is a description of a King Sesostris III, who used prisoners of war to build a canal 35 feet wide and 26 feet deep so that warships could invade, in about 1850 B.C., the neighboring nation of Nubia. And an inscription on

a temple at Karnak records that King Seti I completed a canal from the Red Sea to the Bitter Lakes around 1380 B.C. Still another canal was built during the reign of Pharaoh Necho, about 610 B.C., and a document notes that 120,000 men perished in that effort.

One ancient writer, perhaps anticipating the current plans to build highway tunnels beneath the Suez Canal, complained on his papyrus that there were so many canals in Egypt it was difficult to travel cross

One piece of ship at a time



Two salvage ships, decks almost down to water's surface, have taken on ballast in preparation for lift of dredge Kassar. Before lift is made, however, rock crusher sticking up from sunken dredge will be removed by a crane (center of photo).



A 9600-ton passenger ship, the *Mecca*, had been scuttled in the northern section of the canal. She was one of first wrecks tackled by the Murphy Pacific salvors. In sectioning ship, explosives are used first. Final cuts are made with torches.



Cranes swing cleanly cut, rigid section of the *Mecca* onto bank. "That's the way we like to see them," says a Murphy Pacific salvage man, "because a section like that is relatively easy to handle." Another piece of the ship appears in background.

Together, two Yard Heavy Lift Craft can lift 4000 tons. In some cases, divers are needed to work heavy cables under wreck.

country with animals or wheeled vehicles without encountering a flooded ditch.

It was not until the 19th century that European leaders began to take a serious interest in the political and economic advantages of a canal across the Egyptian isthmus. Napoleon was one of the first representatives of the European power establishment to realize that a canal

through Egypt would bring India, China, and other tempting points in the Orient as much as 5000 to 6000 miles closer to the cities of France.

But it would be years before a canal actually came into existence. All manner of things caused delays—wars, shifts of political power within Egypt, mysterious deaths in Egyptian ruling circles, and changes in plans as Britain and France vied for favor.

The French won out when Ferdinand de Lesseps and the Egyptian

ruler, the Said Pasha, signed a contract for construction of the Suez Canal. On April 25, 1859, the first spade of earth was turned at Pelusium.

Working conditions were not good, even by mid-19th century standards; temperatures in the barren desert frequently reached 120° F. and workers were afflicted with cholera and other infectious diseases. The noted German bacteriologist Robert Koch was sent to the area to study the diseases that devastated the workers

A routine job, say the salvors

and it was there that he isolated the cholera bacillus for the first time.

Work progressed slowly during the early years of the project. The route of the canal was changed several times before actual construction of the maritime waterway was begun. While the Said Pasha was in the driver's seat—he died in 1863—much work was performed by forced labor. His successor, the khedive Ismail, abolished the forced labor system and the work pace picked up. The increased use of machinery and modern engineering methods also speeded progress.

By the summer of 1869, the waters of the Red Sea and the Mediterranean were separated by two dikes, about a mile apart. One day, the dike holding back the waters of the Red Sea at the north end of the Bitter Lakes was opened. A great wall of water rushed through the newly dug channel and up and over the banks of the canal, wrecking machinery and temporary buildings. Workmen were rushed to the second dike to reinforce it before the Red Sea waters could slam through toward the Mediterranean.

The official opening day came on November 17, 1869, with a flotilla of 68 ships from many nations passing in single file southward from Port Said. The Empress Eugenie of France was aboard the lead ship, the *Aigle*, representing France. The slow procession of ships took three days to complete the trip to Suez.

The opening of the Suez Canal was marked by other embellishments seldom equaled in the observance of engineering projects. A carriage road was built across the desert to the pyramids so that distinguished visi-

Present and future of an old canal: If plans are followed, two dredging operations will widen waterway for big ships.



The powerful YHLCs are positioned in the middle of the canal, a section of the concrete caisson cradled between them.

tors could view the treasured tombs of the pharaohs. The khedive spent \$4 million for the development of parks and public gardens, transforming drab areas of Egypt's ancient cities into flowering oases. Street lights were installed along the main thoroughfares of Cairo, primarily for the benefit of visiting Europeans.

But the long celebration was to be climaxed by the greatest cultural event of the decade—the first presentation of Verdi's opera "Aida," commissioned by the khedive for the grand opening. There was a delay in the premiere, however, while France engaged in a war with Prussia; the opera finally had its first performance in 1871 in Cairo.

Through a financial maneuver, the British gained supervisory control of the canal in 1875. According to the

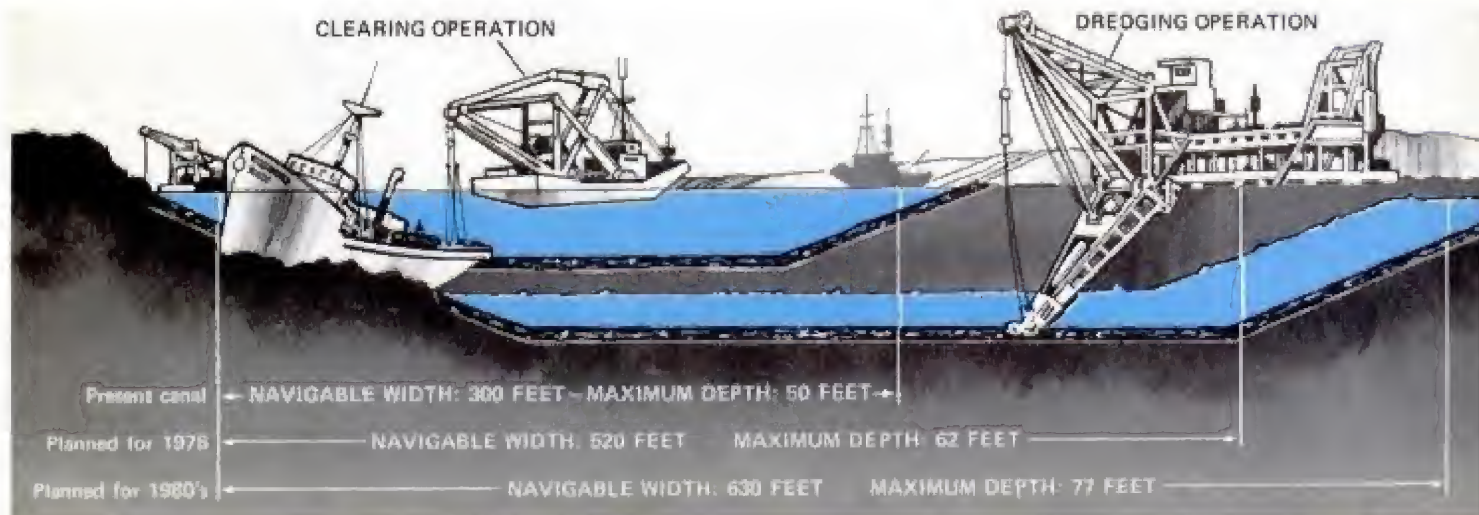
terms of the original lease, Egypt would take over the waterway in 1968. But during a period of Middle East turmoil, Egypt seized the canal in 1956 and President Gamal Abdel Nasser kissed his nation's flag before raising it over the headquarters of the once-powerful British naval base in Suez. During the emotional scene Nasser declared that "120,000 Egyptians died building this canal and it belongs to us." But he neglected to point out that those Egyptians died while working as slave labor under the Pharaoh Necho more than 2500 years earlier.

Nasser's action resulted in a short-lived war. Some 30,000 French and British commandos stormed ashore at Port Said and a similar force of Israelis pushed across the Sinai Desert. The United Nations intervened to prevent the conflict from developing into a full-scale war and dispatched a peace-keeping force to patrol the Suez Canal area until 1967, when renewed fighting resulted in the closing of the canal. Dozens of sunken ships, dredges and other watercraft blocked the 103-mile channel.

Many of these craft were still there in 1974, when the Egyptian government announced its plans for a modernized and greatly enlarged canal. First, the canal had to be cleared of other mementoes of the '67 war—mines and other explosives. American naval units, as well as British and French minesweepers pitched in.

The job of clearing the 10 biggest wrecks from the canal was given to the Murphy Pacific Marine Salvage Co. of Emeryville, Calif., a company that can trace its origins to the start of a professional American salvage industry in 1860. Over the years Murphy Pacific has handled hundreds of tanker salvage jobs in addition to

(Please turn to page 194)



... Even a bigger Suez will be a tight squeeze for

The supertanker: A quarter mile of seagoing oil

Selections from the book *Supership*
by Noël Mostert

With keels sometimes clearing channel bottoms by as little as two or three feet, supertankers carrying hundreds of thousands of tons of crude oil can create disaster for surrounding shorelines if their hulls are pierced. Groundings, collisions and sinkings have already occurred. To describe the growth of this new breed of oil tanker and the problems of maneuvering the giants, PM reprints here excerpts from the bestseller, Supership. The author, Noël Mostert, sailed aboard the S. S. Ardshiel, a 1063-foot-long British supertanker with a capacity of some 206,000 tons of crude oil.—The Editors

Oil tankers, a once obscure and largely unremarked race of ships, have established themselves during the past fifteen years as the dominant vessels of the age and, arguably, of all time. They qualify in both respects merely on grounds of size. They are the biggest ships that have ever been, their dimensions being one of the technological audacities of the century. Most of all, however, they qualify because no other ships have ever been so universally important, none more political. They were the harbingers of that new manifestation of global strategy and national self-interest, the energy crisis; it was to keep them moving that Britain and France landed their troops at Suez in 1956. Much broader and more subtle implications now rest upon their safe voyaging. They have become indispensable to so much more of the world than at the time of Suez that they are now pivotal to global peace and economic survival to a degree that could not have been easily visualized even then.

The fate of much of mankind often has been affected by ships of various kinds, usually fighting ones, and the survival of individual nations occasionally has been dependent upon shipping as a whole, as Britain's was for periods during World War Two, but there never was a time when the viability of life for millions in both hemispheres was inextricably linked to the daily unimpeded passage of any one class of merchantmen. Oil tankers are the first to hold this peril-

ous distinction, because they are quite simply the principal means of carrying the world's oil from where it is to where it's needed. Without them, much of the world would simply stop, and it is a circumstance that will remain with us until oil has been replaced as a principal source of the world's energy and fuel, which no knowledgeable authority supposes to be possible before the end of this century. When that time comes, these monster ships, like the dinosaurs, will swiftly vanish.

Meanwhile, they are still in their ascendancy. They get steadily bigger, and their influence upon our lives and well-being waxes proportionately. In fact, one of the most astonishing aspects of these ships is the very rapidity with which universal dependence upon them has grown.

★ ★ ★

According to the United Nations, U.S. oil consumption per head in 1970 was the equivalent of 7.4 tons against a world average of 1¼ tons, and a British one of 3.6 tons. The United States in 1972 consumed 776,200,000 tons of oil, which was 70 million tons more than western Europe's entire consumption, and more than double Japan's.

★ ★ ★

Oil tankers are hardly new to American waters. The prototypes of the modern tanker were designed a century ago to carry American oil overseas. But oil ships such as the S.S. *Ardshiel* have taken maritime matters not only into a new physical dimension but also into a bewildering, complex, and even sinister new experience. Mere comprehension of the world's fleet of oil ships, whether



One of largest tankers afloat, *Globtik Tokyo* weighs 476,025 tons, is 1250 feet long and draws 92 feet when loaded.

singly or collectively, requires some effort of the imagination. In the simplest terms, it means that at this moment hundreds of ships each several times the size of the old Cunard *Queens* and entirely filled with oil are sailing around the seas.

On December 31st, 1973, there were 388 ships of 200,000 tons deadweight or over in service, and 493 more under construction or on order. Of these, 119 were in the 260,000 to 280,000 ton class, and 26 were of more than 400,000 tons deadweight. The *Ardshiel*, with just over 200,000 tons, was, on that summer's day of her departure for the long voyage to the Middle East and back, a quite ordinary and unexceptional unit among the 3,359 tankers now engaged in the business of delivering the world's oil and petroleum products.

★ ★ ★

As supertankers get bigger, so do their problems. Indeed, if there were a ratio between problems and size it probably would show a proportionate increase with each advance in size. Navigation of these ships is virtually a new skill, even to the extent that they involve forces never before seriously considered in relation to ships: their size makes them the first of man's surface vehicles likely to be affected by the earth's own rotation.

Large masses moving on the earth's surface are affected by the global spin. This effect is known as

(Please turn to page 195)

From *SUPERSHIP* by Noël Mostert. Copyright © 1974 by Noël Mostert. Reprinted by permission of Alfred A. Knopf, Inc. Some of this material originally appeared in *The New Yorker*.



Plastic cutting board is sanitary, non-absorbing, dishwasher-safe. FDA, USDA approve clear Plexiglas for such use.

Stepladder is a clever project for indoor gardeners. Excellent for displaying plants, it can be placed anywhere.



CUTTING BOARD

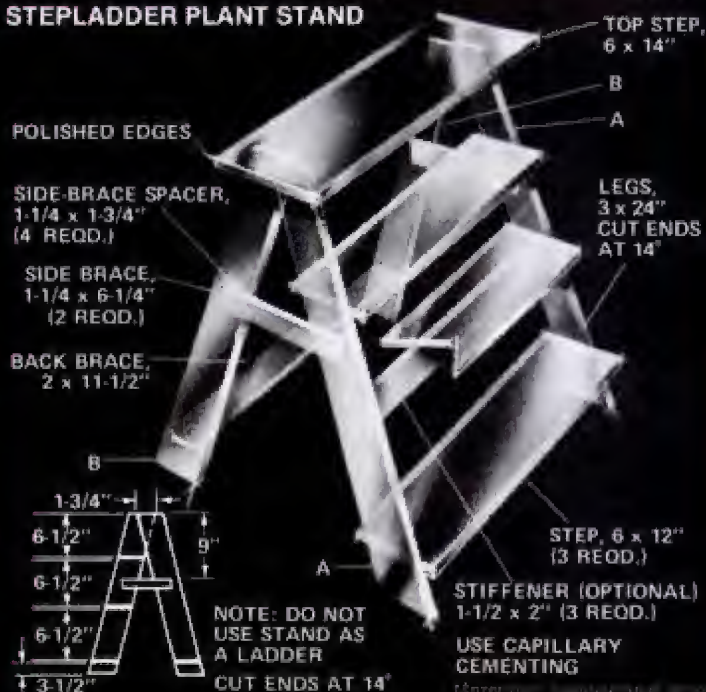


Pretty, easy projects in plastics

by Harry Wicks
WORKSHOP EDITOR

Art: Bernard Benjamin

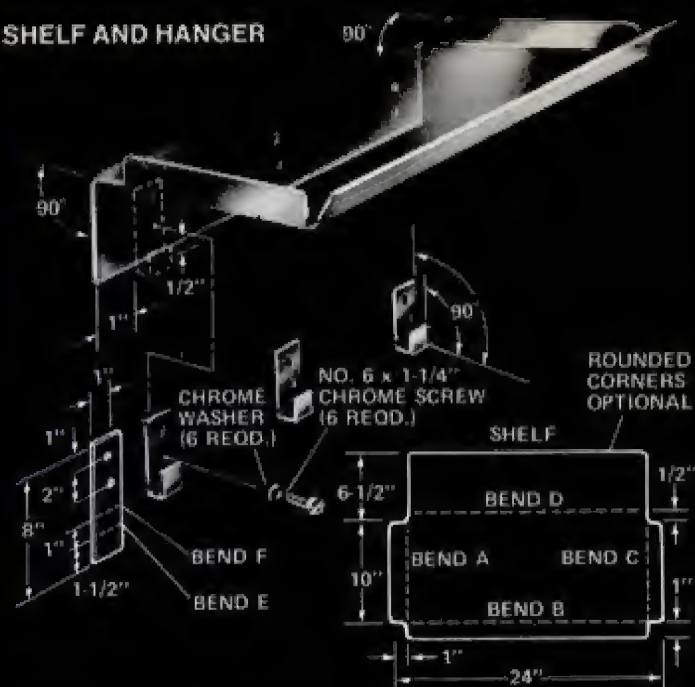
STEPLADDER PLANT STAND





Hat shelf/coat rack can be hung on wall next to mud room or kitchen door to provide a neat and convenient way to stow youngsters' outerwear.

SHELF AND HANGER



Though many beginning do-it-yourselfers think otherwise, there's no ironclad rule that says an exciting, functional project must be hard to build. The well-designed, easy-to-make projects on these pages prove that's not so. Created from acrylic sheet plastic such as Plexiglas, all four are typical of the clear, gleaming household items that are now so popular in the fashionable boutiques and better department stores.

All except the coffee table are made entirely of sheet acrylic, and even that one can be kept completely in the plastics family by replacing its wood top with a piece of opaque sheet acrylic. The four pro-

jects are fashioned of 1/4-in.-thick material currently priced from \$2.50 to \$3 per square foot.

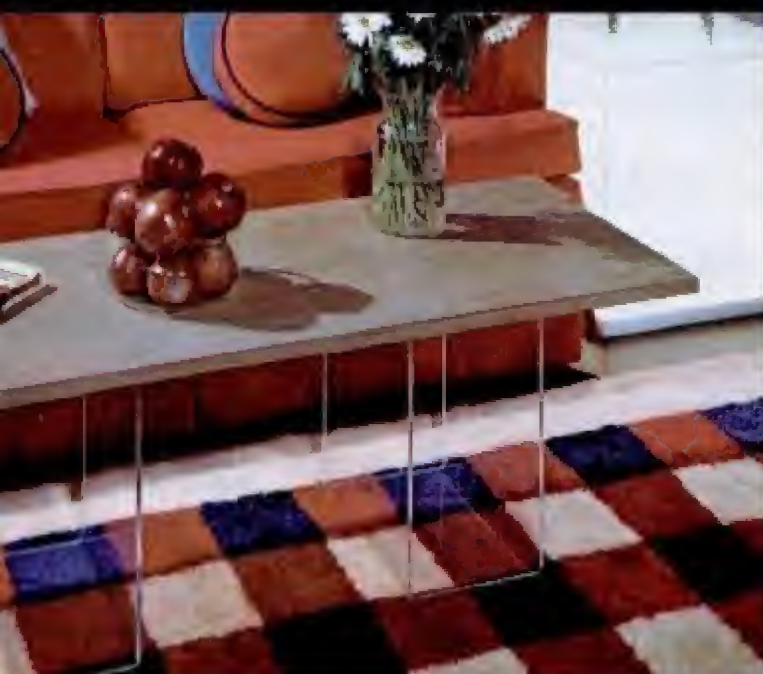
This plastic material is easily worked and requires little in the way of tool investment. The following know-how is a crash course in working with sheet acrylic; for more details, send for the material described at the end of this article.

■ **Cutting.** Leave the protective paper on during the cutting operation and use either a sabre saw equipped with a fine-tooth blade (32 teeth-per-inch) or table saw and plywood-veneer blade. You can also make straight cuts with a special hand tool sold by plastics dealers.

■ **Drilling.** You can use conventional twist drills to

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Coffee table, which stands 16 inches high, is made by combining a favorite wood with a pair of U-shaped legs fashioned of clear acrylic.



COFFEE TABLE



STEREO SWITCHERS: Accessories

Modern stereo systems have twice as many tape monitor jacks as they used to—but up to six times as many things to plug into them: decks for open-reel, cassette and 8-track tape; noise reducers; frequency equalizers for the system (and possibly others for the speakers)—plus whatever the industry may introduce next year. And though some amplifiers have connections for speakers in several rooms, others don't.

For all these problems (and some others), hi-fi accessory makers offer a slew of solutions in the form of



TAPE AND INPUT SWITCHERS

1. Russound TMS-1W lets you mix, dub to or from any of three tape decks, even tape a program on one deck while dubbing another's tape onto a third deck and monitoring any of them you please. In the wood cabinet shown, it's, \$34.95, or \$5 less in metal.

2. Powercom Program Control Center has provisions for one recorder, plus three other stereo signals (marked for FM, TV, PHONO and MIC, but usable for any high-level signals) and two mono ones (AM and TV). It has switches for stereo and mono operation and to attenuate speaker-level signals. Inexpensive, it's just \$15.

3. Sony SB-300 lets you record from your amplifier onto three tapes, copy one tape while recording separately from your amp, or dub from one tape deck onto the other two. Slickly styled, it's \$60.

4. Dubie, which as the name suggests, is for dubbing, also takes three recorders, but has separate level controls for amplifier and tape output levels for easier mixing. In walnut as shown, it's \$80; in vinyl, \$60.

5. GC Audiotex Stereo Input Selector simply lets one pair of input jacks handle three stereo signal sources: It's model 30-5010, \$17.95.

6. "Switch-it" takes three recorders (two through rear panel, one through front-panel jack), allows dubbing, mixing, monitoring or recording in any combination.

7. Eltron Mini-Mix performs same functions as Russound TMS-1W above it, but has clearer panel indications, is less compact, and comes in choice of gold or avocado front panels, costs \$34.95.

ndle your accessories



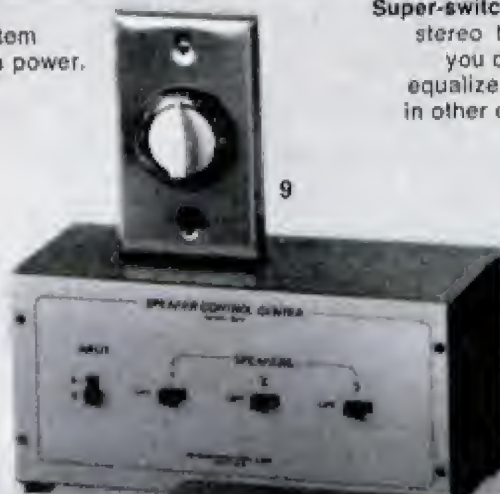
Control 1 doesn't switch signals, it reads them—if no sound has come from your system for 10 minutes or so, it switches off the system power. Made by H. R. Manufacturing, sells for \$40.



Super-switcher Russound QT-1 takes four 4-channel or stereo tape decks, equalizer, noise reducer, lets you copy tapes from one deck, listen to another, equalize in record or playback, mix channels, patch in other components through the front. Cost is \$249.



11



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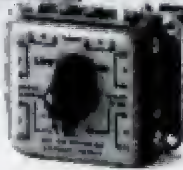


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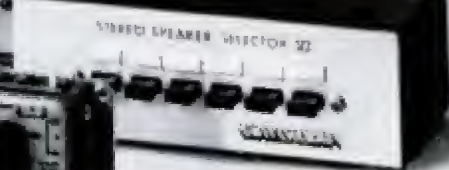


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16



SPEAKER SWITCHES AND CONTROLLERS

8. Russound Multi-Play MP-2 lets you connect any of four speaker pairs to either or neither of two amplifiers, has volume controls for each pair, costs \$69.95.

9. Switchcraft No. 657 dial switch fits standard outlet boxes for wall mounting, selects any, all, or any two of three speakers, maintains constant impedance, comes in brass or stainless panel, \$12.

10. Eltron Speaker Control Center SC-1 has individual on-off switching for three pairs of speakers; input switch selects either of two amplifiers. In gold or avocado panel with wood case, it's \$27.95.

11. Eltron SC-2 Speaker/Amplifier Control Center, like Russound above it, has sep-

arate amplifier or off selectors and volume controls for four pairs of speakers, costs \$74.95 in wood with choice of front-panel colors.

12. Switchcraft No. 670P1 selects either or both of two speaker pairs, costs \$8.

13. Switchcraft Speaker Selector VI takes six speaker pairs, comes in interlock version (Model 644), taking only one pair at a time, or independent-button version (Model 645) allowing combinations; either for \$48. Fancier, eight-pair versions are \$95 each.

14. Russound Multi-Play SWB-2W has on-off switches for three speakers, input selector for two amplifiers, costs \$26 in wood case shown, \$20 without.

SOUND-ON-SOUND AND ECHO SWITCHERS

These simplify sound-on-sound recordings made by dubbing from one track to another, by mixing in new material, and stereo echo on three-head machines.

15. Sony SB-200 has knob for use with tape decks having no separate output level control, has separate echo button, costs \$50.

16. TEAC AX-10 similar, also has input impedance selector switch, is \$50. AX-20 (not shown) has no level control, but also allows mix-down from 4-channel to stereo or stereo to mono, costs \$30.

switchboxes, like the ones shown here, that simplify elaborate systems. They're not really necessities—but without them you'd have to delve through snarls of cables hidden behind your hi-fi to plug and unplug connections, or cascade one accessory through the jacks of another with the likelihood that one misset switch could cut your signal altogether.

Still another connection system comes from broadcast and recording studios: the patchboard.

Patchboards let you plug anything into anything else at a moment's notice, without rearranging hidden cables. Studios use them for reliability (a spare component can be patched in place of a broken one in seconds), but you can use them (as

studios also do) for experimental connections—the running of a signal through an equalizer en route to a recorder, for instance.

Studio-rugged patchboards like the one shown are expensive, but you can build your own, more modest one, using less expensive jacks. The principle is shown below: Use jacks whose internal contacts disconnect once a plug is inserted in the patchboard. When the plug is removed, the normal connection is instantly restored.

For example, if one of your tuner outputs fed the upper jack in the diagram below, plugging into that jack would give you a tuner signal which you could then feed directly into your tape recorder's input jack (also on the patchboard). This lets

you bypass the amplifier and tape an FM program while listening to something else. Or you could plug a portable recorder into the amplifier's tuner input, via the lower jack, for playback.

For simplicity's sake, we've shown two-conductor jacks and plugs, which use the plug shields and jack frames as grounds (the frames of the upper and lower jacks in our example would then be wired together, too). It's sometimes better to use three-conductor phone jacks which break *two* connections when a patchcord is plugged in; using the second breakable connection for the ground may reduce hum.

Patchboarding is a lot of trouble and expense, but nothing else gives you such flexibility—if you should need it.

The Russound QT-1 on page 75 combines both patching and switching. The upper jacks are "normalled through" for standard recording operations, while the lower jacks (for equalizers and noise reducers) are not normalled, allowing those accessories to be patched anywhere into the record and playback circuits. With extra cords (not supplied), you can also plug your auxiliary equipment in through the Russound's front panel. ★★★

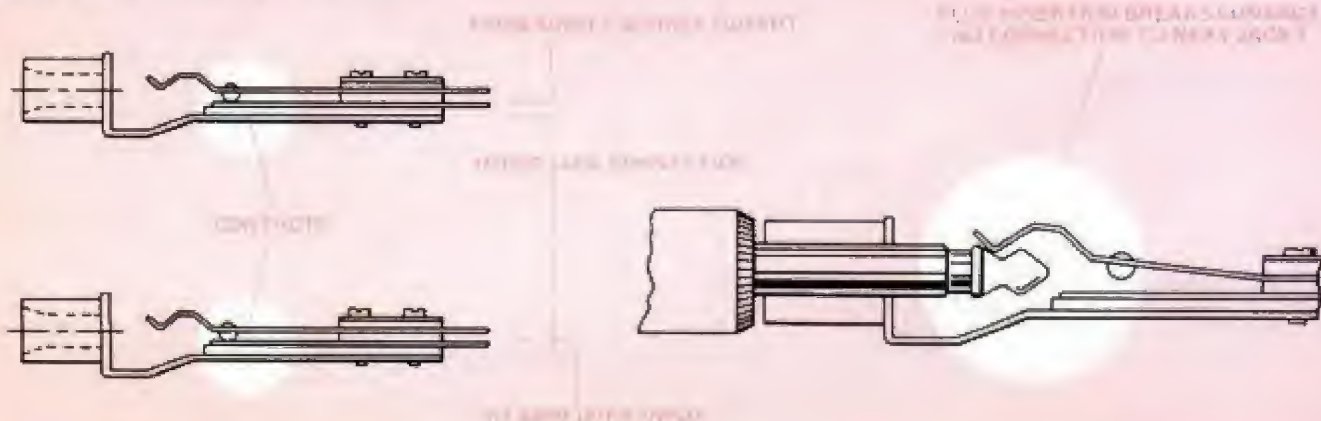
Stereo switchers like this Powercom unit help tie together complex systems, give you extra inputs to handle accessories such as equalizers, noise reducers, reverb units, extra tape decks and whatever else will be coming along next.



Patchboards connect anything to anything, fast. "Normalled" wiring makes standard connections without patchcords. Modular construction on this Switchcraft patchboard (right) simplifies rewiring and repair of jack connections.



"NORMALLED-THROUGH" PATCHING





Mini rigs for maxi action

More go with less gas

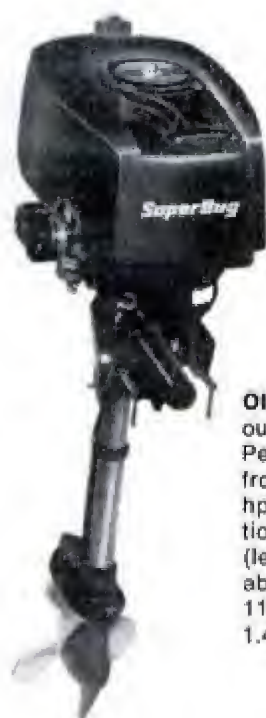
by Ray Gill

As fuel gets shorter in supply and prices go up, small rigs look more and more attractive. There are plenty of good uses for the big high-horsepower motors, of course. But so many of the muscular midgets have been newly redesigned and improved to provide more push for your

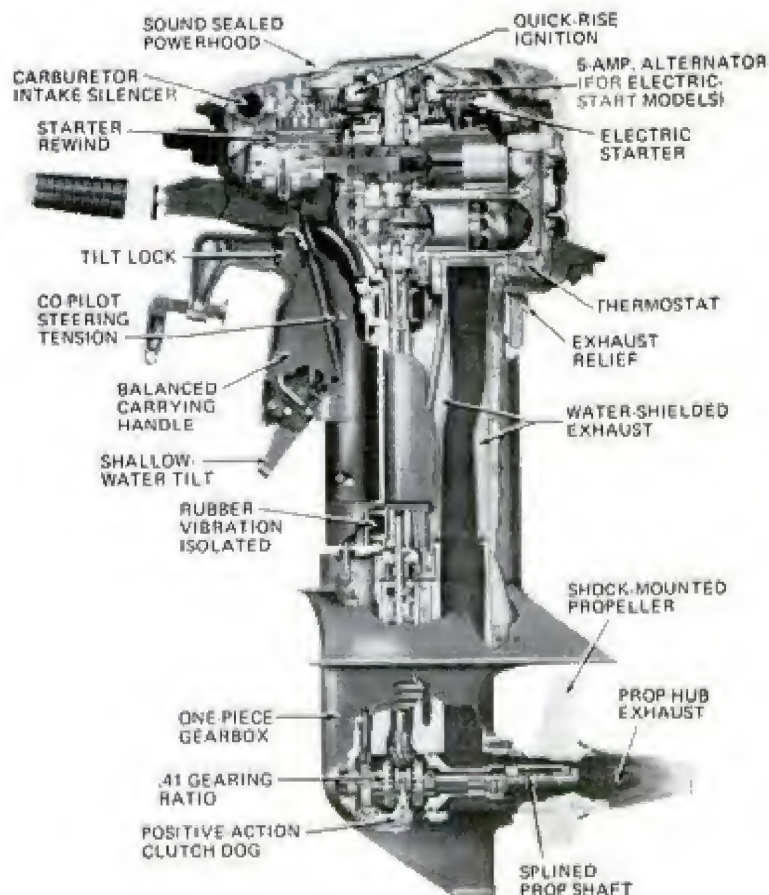
Little motors from the big companies include two hp by Evinrude (above), five from Eska (at left). Johnson, Mercury and Chrysler also offer small motors with plenty of muscle for dinks, skiffs, canoes.



Tilt-up trolling makes it possible (above) to chase lunkers in around stumps. But big-motor features, as shown in cutaway below, are also being introduced in Johnson and Evinrude 9.9 and 15-hp models.



Old inboard name on new outboard motors, Volvo Penta is introducing nine, from 3.9 (above) up to 70 hp. From AquaBug International is the new SuperBug (left) an 18-pounder of about 2.5 hp for \$200. Its 11-lb. AquaBug, with about 1.4 hp, currently sells at \$150.



money and more efficiency that they're earning new popularity.

Here, too, is where the traditional arguments between the wind sailors and powerboat skippers end. Both can make good use of a mini-motor as auxiliary power to get home when the wind goes down or the main engine runs the big tank dry. Many small outboards now come in extra-size shaft lengths or with optional shaft extensions so they can be fitted on the high transom of a sailboat.

Sizes range from about 1.2 hp up to the 20 and 25-horse "big little" motors. Sources range across the United States, Europe and Asia, with new entries being imported from Sweden, Germany, Italy and Japan. The little kickers have always been known as fishing motors, but now the larger models can tow small water skiers, and they are proving to be the ideal economy and convenience power for canoes, dinghies, inflatables, small work boats and jon-boats, pontoon craft, rafts and row-boats, and even offer slow-speed push for hulls as large as houseboats.

Styling, easier handling and better performance improvements are being adapted to the little mills. Look for electric and recoil-rope starting, tiller throttles, gearshifts and underwater exhausts, plus better weed protection for props and better gear protection from monofilament line than the big motors have. Inside, many of this year's small outboards will have less bulk and weight, solid-state ignitions that have no breaker points to wear out, plugs that can take extensive trolling without fouling, drainless crankcase recycling to prevent water pollution. Loop charging and loop scavenging of the big-

ger engines are being used to improve the performance of minis, as well. But prices have not been soaring to match; Sears, for example, is planning an economy 7.5-hp model for about \$200.

This year there will be a wide choice of mini-mills. Here is a spot check of some of them:

■ Eska, the largest exclusive producer of small outboards, has a completely new 3-hp model this year with improved fuel economy, Power Loop design, and antipollution devices as on all its models. Eska's water-cooled motors have been redesigned to include 9.9 and 15-hp models. Both have solid-state ignition and preset carburetors for easy starting.

Eska's two 7.5 air-cooled motors have solid-state ignition and capacitor discharge. One has full gearshift, while a newer model offers forward and neutral plus a full pivot for reverse. This year's 5.5-hp has a safety twist-grip control like the larger Eska models. The new 4.5 and 3 are air-cooled and have full pivot forward-reverse drives. Improved weedless propellers and new line guard seals, plus larger clamp brackets and easy-to-handle panel controls are features of the Eska 5.5s, 4.5s and 3s.

■ Chrysler's "Swinger" economy motors have 3.6 and 5 hp. Both have integral fuel tanks and new plastic engine covers, plus new carburetor and powerhead for the 5 for improved starting, and fuel economy. The 6, 8, 10 and 15-horse models, the "Low Profile" lightweights, have either manual or autoelectric starting, improved economizing carburetors and twist-grip throttle controls. The 10 and 15, with three-bladed props, are available with 5-inch and 15-inch extensions. Called "family size" models by Chrysler, the 20 has a new waterproof shutoff switch and the 25 a five-amp. alternator for battery charging.

■ Top of Evinrude's small-motor line can also be classed as the bottom of the big-motor line. The Evinrude 25 hp is a small motor because of its 85-pound portability—a big motor because it has such big-motor features as thermostat-cooled twin cylinders, pressure-backed piston rings and Quick-Rise ignition for easy starting. It's available in manual and electric-start models. The Evinrude 15 has the same high-intensity igni-

tion, water-cooled midsection and prop-hub exhaust of the larger models. A favorite as a sailboat auxiliary it has optional top-mounted controls, long fold-away steering tiller, five-inch shaft extension and manual or electric start.

Introduced last year, Evinrude's new 9.9 has many of the features of the 15, plus programmed tilt and shallow-water drive for trolling. The 6 also has big-engine features. Evinrude 4s come with 90° drive for one model, angled fisherman's drive for the other for sliding over shoals, and shock-mounted semi-weedless prop. Steering is 360° pivot; throttle controls are side-mounted.

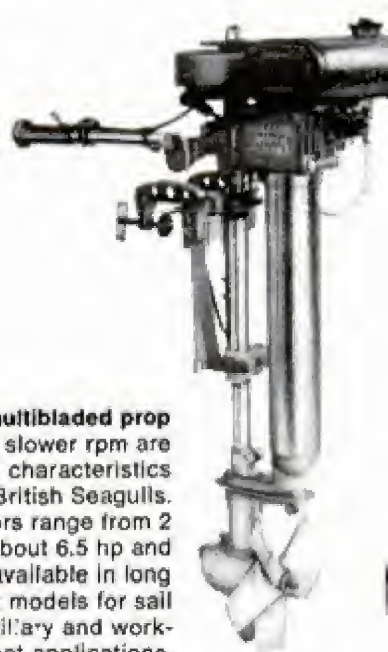
At only 24 pounds, the Evinrude 2 can be easily shoulder-toted and a portage pack is optional. Quietest this year, it also has an optional side mount for powering a canoe, and five-inch shaft extension.

■ Johnson considers its 25 an economical lower-powered twin of the Sea-Horse 40. Both feature pressure-back piston rings, full shifts and fuel-saving throttle linkage plus high-voltage ignition. On Johnson 1 and 9.9, motors this year there are new longer handles for steering and twist-grip throttle controls, heavier flywheels for easier starting with both electric and manual-start models. Manual 9.9s and 15s can be one-hand started in gear at low trolling speed while you hold a fishing rod in your other hand. They also have thermostat-controlled cooling, programmed shallow-water tilt-lock, top controls and heavy-duty props as options for sailboat powering.

The Johnson 6 also has an accessory heavy-duty prop, the 4s comes in straight or Angle-Matic model



Light 11-pounder from Sears, the Ted Williams 1.2-hp air-cooled motor is a new addition to the line of nine outboards up to 15 hp. The 1.2 has adjustable shaft length, recoil starter and underwater exhaust.



Big, multibladed prop and slower rpm are among characteristics of British Seagulls. Motors range from 2 to about 6.5 hp and are available in long shaft models for sail auxiliary and workboat applications.

and low-profile, three-gallon tanks, and the Johnson 2 has a new air silencer to further reduce noise.

■ Mercury's line of small outboards includes a new 4.5, called the Merc 45, to replace its 4-horse Merc 40. Then there is a Merc 75 of 7.5 hp, a Merc 110 of 9.8, and the 20-hp Merc 200.

The new Merc 45 has a special stop switch to turn off the engine more quickly. Merc 7.5 and 9.8 models now use a carburetor having a solid choke plate for easier starting, improved idle circuit for better fuel flow, and an auxiliary lighting coil kit to provide power for running lights and battery charging. An electric starting kit is also available as an option for the Merc 200. All Mercurys are water-cooled with fixed-jet carburetors which require no adjustment during normal operation, jet-prop underwater exhausts, internal fuel recycling.

■ Clinton's single-cylinder air and water-cooled models now include the 3-hp K-300, the 5-hp K-500, 7-hp K-700, a new 7.5-hp K-750, the work-horse 9.9-hp K-990, and new this year: the improved Clinton 1.5-hp K-150.

■ Rugged reliability is the reputation of British Seagull's line, with its 2-hp Forty Featherweight, the 3-hp Forty Plus, 5-hp Silver Century, and the 6.5-hp Silver Century Plus.

■ Honda has a new four-stroke outboard of 7.5 hp called the Honda B-75 K1. Rated as both quiet and powerful, the engine does not require the premixing of oil with the gasoline. Good gas economy is reported; standard SAE 10W-30W oil is added separately and pressure fed to all bearing surfaces.

■ For power without a propeller for snag-free operation wherever your boat will float, plus added safety around swimmers, there is the unusual Otterbine outboard. These four-cycle Briggs & Stratton-powered jet-drive units come in three shaft lengths and in models of 3½ hp, the BSOJ 2; the 5-hp BSOJ 3; the 8-hp BSOJ 5; and the 10-hp BSOJ 7.5. All mount almost flush with the bottom of your boat, and are claimed to provide economical as well as safe propulsion.

Diesel and Wankel rotary-power outboards produced abroad have also been announced recently and should be available shortly. Outboard power with no prop in the water is possible with the aircraft-engined clamp-ons for airboat action. And if you are after real gasoline economy, consider the newly popular little 12-volt and 24-volt electric trolling motors. Clamped on your bow or stern, they won't use any gas at all. ★★★



Mercury's minis run from a new 4.5 (Merc 45) through 7.5 and 9.8 to the 20 hp (Merc 200) and up. Merc 45 replaces Merc 40. Fishermen at right are using 11 hp.



Jet power from outboard? Otterbine four-cycle water jet models come in three shaft lengths and four Briggs & Stratton power heads of 3½, 5, 8, and 10 hp. Snag-free operation is claimed.



Lightweight rigs, like inflatables, favor light motors like Chrysler 5 (above). This year Chrysler has models of 3.6, 5, low profile 6, 8, 10 and 15, plus 20 and 25.



No gas at all, for real fuel economy, is needed with the many electrics, like this Johnson, now available for trolling in where the lunkers (and the mosquitoes) are likely to be.

Is the similarity to Mercedes more than skin deep?

A nationwide survey based on 990,295 owner-driven miles.

by Michael Lamm WEST COAST EDITOR

Photos by the author



Granada and Monarch win this year's Mercedes look-alike contest, but should they be compared with the Stuttgart Standard in other ways? Is the Mercedes influence more than skin deep?

Ford Motor Co. doesn't deny lifting a few lines from the Mercedes 280 and, in fact, capitalizing on what Ford calls "the precision-sized car." Nor is Ford the only automaker copying Mercedes these days—the Audi 100LS has done it successfully for years, and the new GM compacts (Nova, Ventura, Apollo and Omega) also borrow the same squared-off, no-nonsense styling.

"Precision" doesn't extend to the trunk. Owners say the spare takes up most of its space.

The Mercedes 280 sedan lists for over twice the base price of a Granada.

However, the Granada and Monarch weren't originally meant to become so Mercedes-like, and that's one reason why a point-by-point comparison wouldn't be fair. The other reason is the big difference in price.

Ford product planners conceived this car several years ago to replace the aging MavCom line (Maverick and Comet). But then the oil embargo hit, MavCom sales perked up, so did a certain demand for small luxury cars, and Ford decided to keep the MavCom. This meant that in order not to compete directly in the MavCom price range, the Granada and Monarch would have to be upgraded in such areas





Mercury Monarch four-door sedan model was choice of 61 percent of Monarch owners in our survey



as interior decor and general appointments to appeal more to those interested in an American Mercedes—at half the price.

It's no secret that the Granada and Monarch are twins—identical right down to their lug nuts except for grilles and trim. Both offer the same engine choices (250-c.i.d. Six plus 302 and 351-c.i.d. V8s), transmissions, suspensions, bodies and everything else. Even their base prices are nearly the same. The Monarch lists for \$3822, the Granada for \$3756, a difference of \$66.

Styling—presumably Mercedes-like styling—topped the list of owners' reasons for buy-

There seem to be differences in workmanship and service, our owner opinion tabulations would indicate.

Relatively few owners admitted the Mercedes resemblance—only about one percent.

ing. A North Carolina gas retailer burbles, "I had a man stop me at an intersection the other day and tell me, 'That's the prettiest car I've ever seen.' It's a Granada Ghia, black." And an Indiana cycle shop operator says, "We bought the first Granada in town; fell in love with it because it resembled the Mercedes. We get a lot of comments and compliments on the car."

But there were many other reasons for choosing these particular autos. Comments a Florida real-estate salesman, "I looked at several different makes before settling on the Monarch. I felt it offered the most in style,



Ford Granada two-door hardtop model was choice of 51.5 percent of Granada owners in our survey



comfort and prestige, all of which are important in the real-estate business. I feel I got big-car looks and feel without paying an outlandish price. I call my Monarch a little Mark IV." And from a North Carolina university researcher: "I wanted a small but not compact luxury-type auto which would serve me well on longer trips."

Some owners, though, are disappointed with the Granada's and Monarch's gas mileage—35 to 39 percent say they'd been led to expect better. "How can anyone tell such lies?" rants a Michigan retiree. "The salesman said I'd get 14 to 18 mpg around town and 22 to 27 mpg on long trips. I'm getting 12 to 16 mpg overall."

Poor gas mileage stands out as Granada/Monarch owners' No. 1 complaint. Observes a Minnesota Monarch owner: "We expected economical driving from a classical U.S.-made automobile. But it's not economical on gas. We have the Six and get only 12 to 14 mpg." An Indiana Granada owner laments, "I was told I would get at least 18 to 20 miles per gallon. With the 302 V8, I'm getting all of 11 to 14 mpg. My 1972 Cutlass used to do better than that, and I traded it in the hope of saving money on gasoline."

How do most owners rate comfort? Nearly 85 percent give comfort marks of *good* to *excellent*. That's a high score for cars of any size. Here are typical comments from drivers of four-door sedans: "I find the car very comfortable both front and rear; passengers like the ride and seats."—West Virginia insurance agent. "Excellent headroom."—Missouri salesman. "Rear seat surprisingly roomy."—Texas travel agent. "I am 6-3 and find the adjustable bucket seats superb. On one occasion I rode 200



Instrument clusters are nearly identical in Monarch (shown) and Granada, with speedometer and gas gauge the only live dials. Large glovebox is centered in dash, and digital clock comes standard in Ghia models of both nameplates.

Both compacts have reclining bucket seats as standard, and make good use of their 200-inch overall length. Plenty of legroom front and rear, say sedan owners, but coupes aren't so generous in back. Ghia Monarch (shown) has cashmere-like nylon knit or leather trimmed in vinyl.

Lower-than-expected gas mileage ranks as Granada and Monarch owners' biggest disappointment.

One reason mpg is so low is because owners tend to load these cars up with accessories.

Sedans get higher marks for comfort and roominess than the coupes. A few owners suggested making a wagon available.

Monarch dealer service seems to be about 10 percentage points better than the Granada's.

Wood-grain trim looks nice but could be better attached, say owners. Monarch got significantly higher workmanship marks than Granada. Despite continental touches, Granada's and Monarch's interiors are more LTD-like than Mercedes.



Map pockets on Ghia seatbacks (Granada coupe shown) marks one of many thoughtful touches. Granada owners praise interior comfort and luxury. Several mentioned trading larger cars, but no one felt cramped. Coupe's rear pillars cut down vision more than sedan's.



miles in the back seat and found it comfortable, too."—Georgia aircraft mechanic.

About the coupe, these notes: "Front fine, back small, but I already knew that when I bought the car."—Jersey computer operator. "Somewhat limited rear legroom."—South Carolina service technician. "Suspension gives firm but pleasant ride."—Iowa housewife.

General workmanship and quality comes in for mixed reactions. Among Monarch owners, 63.8 percent rate workmanship *good* to *excellent*, but with Granada owners the figure drops to 56.1 percent. This might be the significant difference between the two cars. A cross section of workmanship opinions runs like this:

"The Granada, being a first-year model, shows surprisingly good quality control and workmanship—something not found too often these days."—Massachusetts sales manager. "Except for wood-grain moldings on the dashboard coming loose, I would rate workmanship very good."—Oklahoma hairdresser.

But an Arizona office manager observes, "I think my Monarch would be terrific if it could be sent back to the factory and reassembled." Along that line, an Illinois USAF retiree comments, "I'd say my Monarch's workmanship is generally excellent, but I would like to see you point out in your magazine the apparently widespread practice of unsatisfactory dealer preparation. The dealer doesn't do the job right the first time and then gets paid twice—once for 'make-ready' before he delivers the car and again when I have to bring it back. The dealer uses the owner's warranty card to collect the second time."

Dealer service didn't draw any huzzahs from owners, but Monarch purchasers seem to have a slightly better opinion of their service departments than do Granada buyers. Monarchists vote 57.2 percent to rate service *average* to *poor*; Granadans condemn it by 66.6 percent.



Monarch's best mileage is 14.8 to 18.2 with the 250 Six.



Granada's best mileage is 14.5 to 17.6 with the 250 Six.

Very few owners had had mechanical troubles when we queried them, meaning that despite their opinions of dealer service, they hadn't had to take their cars in much. Those who did report troubles followed a slightly inconsistent pattern. For instance, while 17.5 percent of Monarch owners listed transmission problems, no Granada owners did. The malady common to about 11 percent of all Granadas and Monarchs was a malfunctioning heater blower. Many had to be replaced.

When we asked respondents to suggest changes, the most common (predictably) was: "We'd like better gas mileage." Ten to 13 percent want a bigger trunk, and 5 to 6 percent suggest relocating the spare tire, which again amounts to enlarging the trunk. The spare lies smack in the center of the compartment, ruining any possibility of stowing larger suitcases. A space-saving spare is available optionally.

Other I'd-like-to-see changes include: "Eliminate the backswept lower point on the front door of sedans—it has a habit of snagging stockings, and I'm sure that under the right circumstances it could gouge quite a hole in someone's leg."—St. Louis railroader. "I'd like full instrumentation in addition to the idiot

These compacts already carry 90 pounds of sound deadener—more than the Thunderbird.

The 302 V8 proved the most popular and probably the best compromise between economy and performance.

One owner said his wife's leg got gashed by the lower edge of the sedan's front door and needed 22 stitches.

lights."—Maine educator. "More insulation to lock out engine and road noises."—Florida painting contractor. "Change gas tank so the last half gallon doesn't upchuck back out the filler pipe."—California school teacher.

Most owners say they're happy with their cars' performance, but there were a few grumbles from six-cylinder drivers who'd like more snap. The Six with automatic takes its time pulling hills and apparently doesn't win many stoplight drags. On the other hand, owners of Granadas and Monarchs with the 351-inch V8 engine howled the loudest about gas mileage.

Taking everything into consideration, though, owners of these two FoMoCo compacts say they're pleased enough. A New York housewife sums it up this way. "I do like the Monarch very much. It handles so easily, not large and clumsy, but large enough. The four-door is what we were looking for, with separate, movable front seats so I can sit close to the wheel for driving and my husband can sit well back. It's quite roomy inside, and on a trip to Florida recently, we couldn't stop anywhere without everyone coming out and looking at the car." ★ ★ ★

Summary of 1975 Mercury Monarch and Ford Granada Owners Reports*

Monarch Granada		Monarch Granada		Monarch Granada		Monarch Granada					
Total miles driven	507,550	482,745	Economy	40.3	35.4	Relocate spare tire	5.2	6.1	Had any mechanical trouble?		
Average miles per gallon:			Size	36.4	31.0	Number of vehicles owned:			No	59.7%	56.7%
250-c.i.d. 6			Comfort	10.4	N.a.	This one only	46.3%	49.4%	Yes	40.3	43.3
Local driving	14.8	14.5	Price and			Two cars	42.7	41.5	Type of trouble:		
Long trips	18.2	17.6	"for a change"	7.8	7.6	Three cars	9.1	7.3	Transmission	17.5%	0.00%
302-c.i.d. V8			Specific likes:			Four cars	0.6	1.8	Carburetor	14.3	10.0
Local driving	12.1	12.2	Styling	41.1%	66.0%	Five or more cars	1.2	N.a.	Heater blower	11.1	11.4
Long trips	15.4	14.9	Handling	54.1	45.9	Other cars owned:			Oil leaks	9.5	N.a.
351-c.i.d. V8			Comfort	40.1	40.9	Ford	10.5%	29.3%	Electrical	9.5	8.6
Local driving	10.8	N.a.†	Ride	29.5	29.6	Mercury	14.3	N.a.	Power steering	9.5	8.6
Long trips	14.1	N.a.	Economy	18.5	10.1	Lincoln	12.8	N.a.	Did you repair it yourself?		
Engines:			Size	18.5	17.6	Chevrolet	18.6	13.4	No	92.2%	97.1%
250-c.i.d. 6	20.5%	33.7%	Specific dislikes:			Volkswagen and/or Pinto	10.5	7.3	Yes	7.6	2.9
302-c.i.d. V8	65.8	62.0	Poor gas mileage	39.0%	35.8%	Comfort opinion:			Dealer repairs satisfactory?		
351-c.i.d. V8	13.7	4.3	Poor workmanship	14.9	5.7	Good to excellent	84.4%	83.4%	Yes	52.7%	57.9%
Body styles:			Noisy	8.4	7.5	Average to poor	14.9	15.7	No	47.3	42.1
Four-door sedan	61.0%	48.5%	Poor trunk space utilization	8.4	9.4	Workmanship opinion:			Age distribution of owners:		
Two-door coupe	39.0	51.5	What changes would you like?			Good to excellent	63.8%	56.1%	15-29 years	19.8%	21.7%
Transmissions:			Better gas mileage	22.2%	23.5%	Average to poor	36.2	43.9	30-49 years	35.4	40.2
Automatic	88.3%	87.7%	Bigger trunk	10.4	13.6	Dealer service opinion:			50 and over	44.7	38.2
Three-speed manual	11.7	12.3	Better workmanship	7.4	N.a.	Good to excellent	42.9%	33.3%	Would you buy another next time?		
Why did you choose this car?						Average to poor	57.2	66.6	Yes	67.9%	68.5%
Styling	50.6%	55.7%							No	32.1	31.5

*Percentages might not equal 100% due to rounding or insufficient data.

†Too few replies to tabulate



Kirsch photo; Hedrich-Blessing

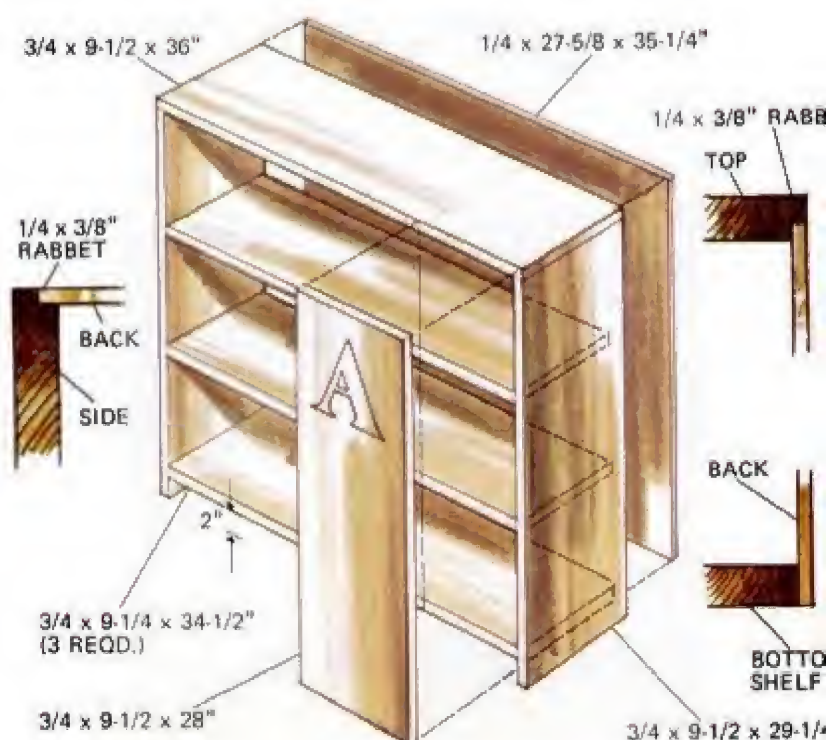
WEEKEND PROJECTS

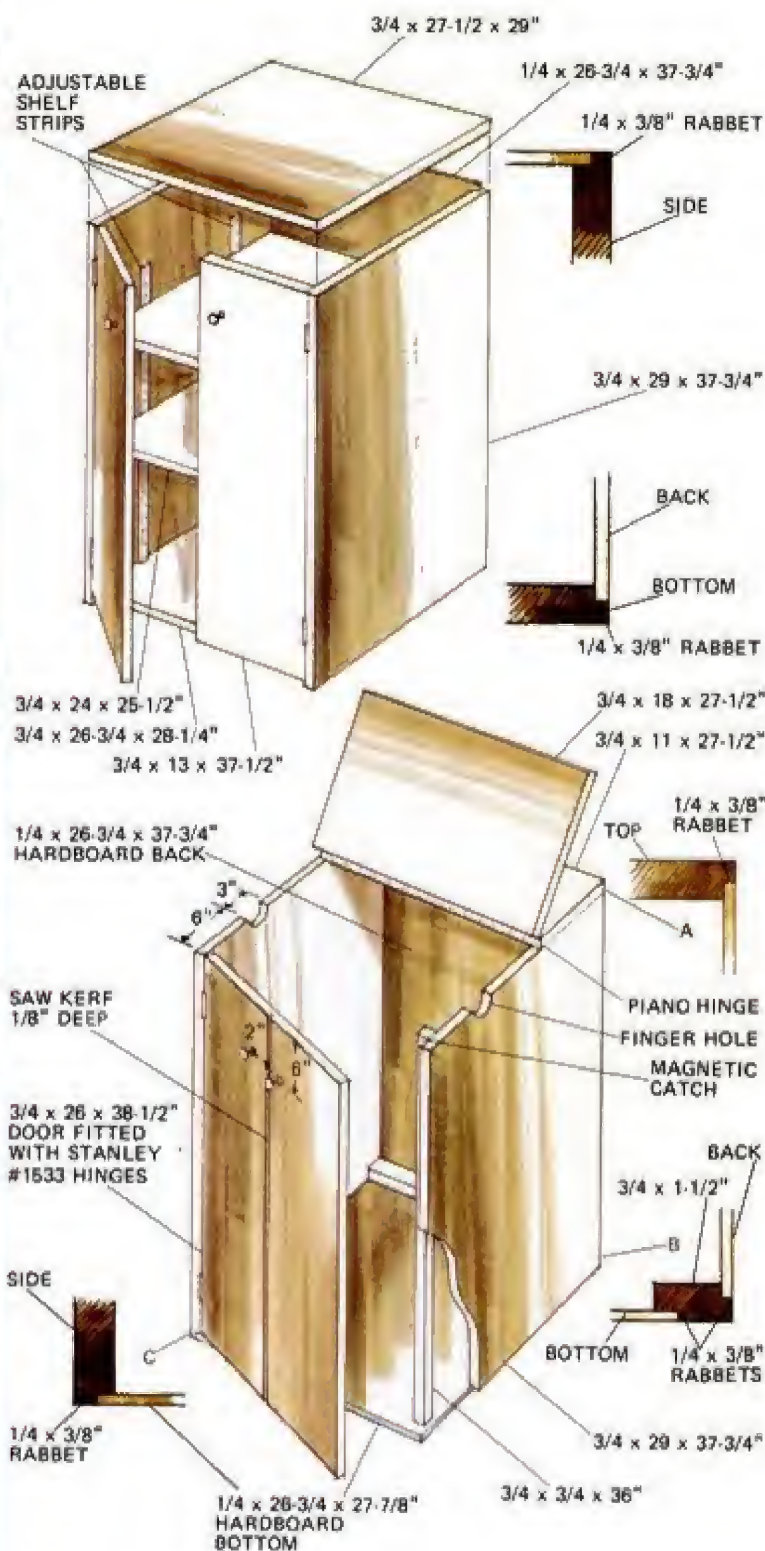
Two decorative stowaways

by Wayne C. Leckey
HOME AND SHOP EDITOR

A mud room need not look like a mud room. It can be the gay and colorful entry you see here. With shelves standing by to corral boots, lunch boxes, jump ropes and baseball gear, the family back-door entry takes on anything but the look of a corner catch-all. When the shelves are painted lively colors to tie in with matching colors on the entry door itself, the overall effect adds a touch of excitement to the surrounding area.

There's nothing to making such a shelf unit. For maximum simplicity, the whole thing, except for the back, is made from stock 1 x 10 boards which you just saw to length. If rabbets pose a problem to cut, forget them and let the plywood back lap the rear edges. The jigsawed letters can be the youngsters' initials.





Art: Adolph Brotman

When a convertible dishwasher can join in and be a part of a cooking/serving center, it's almost better than having a built-in unit, even when there is room for one. In this case there wasn't, but there was still the question of where to park a convertible out of sight when not in use. The answer was the clever side-by-side storage unit, shown above, which provides not only the perfect hideaway for a convertible dishwasher but also lots of storage for small appliances and bulky serving dishes as

well. What's more, the top of the hideaway lifts up to reveal a handy wood cutting block perched on top of the dishwasher. When it's completely closed, no one would ever guess there's a dishwasher parked inside.

The twin cabinets have wipe-clean plastic-laminate tops and sides covered with natural grass-cloth vinyl accented with screen molding painted bright orange to match countertops.

Both boxlike cabinets are identical in overall size, the washer cabinet being dimensioned to accept a

Maytag convertible. Except for the 1/4-in.-hardboard bottom of the washer cabinet and the backs of both, 3/4-in. plywood is used throughout. The joinery can be simplified where the work is being done primarily with hammer and saw. Rabbet joints add to overall sturdiness and offer no problem when you have a table saw. However, the backs can be merely lapped and nailed. The washer cabinet has a single door made to look like double doors by running a saw kerf down the middle. ★★ ★

Build this 762-mm lens for \$35

by Lane C. Sander

Photos by the author

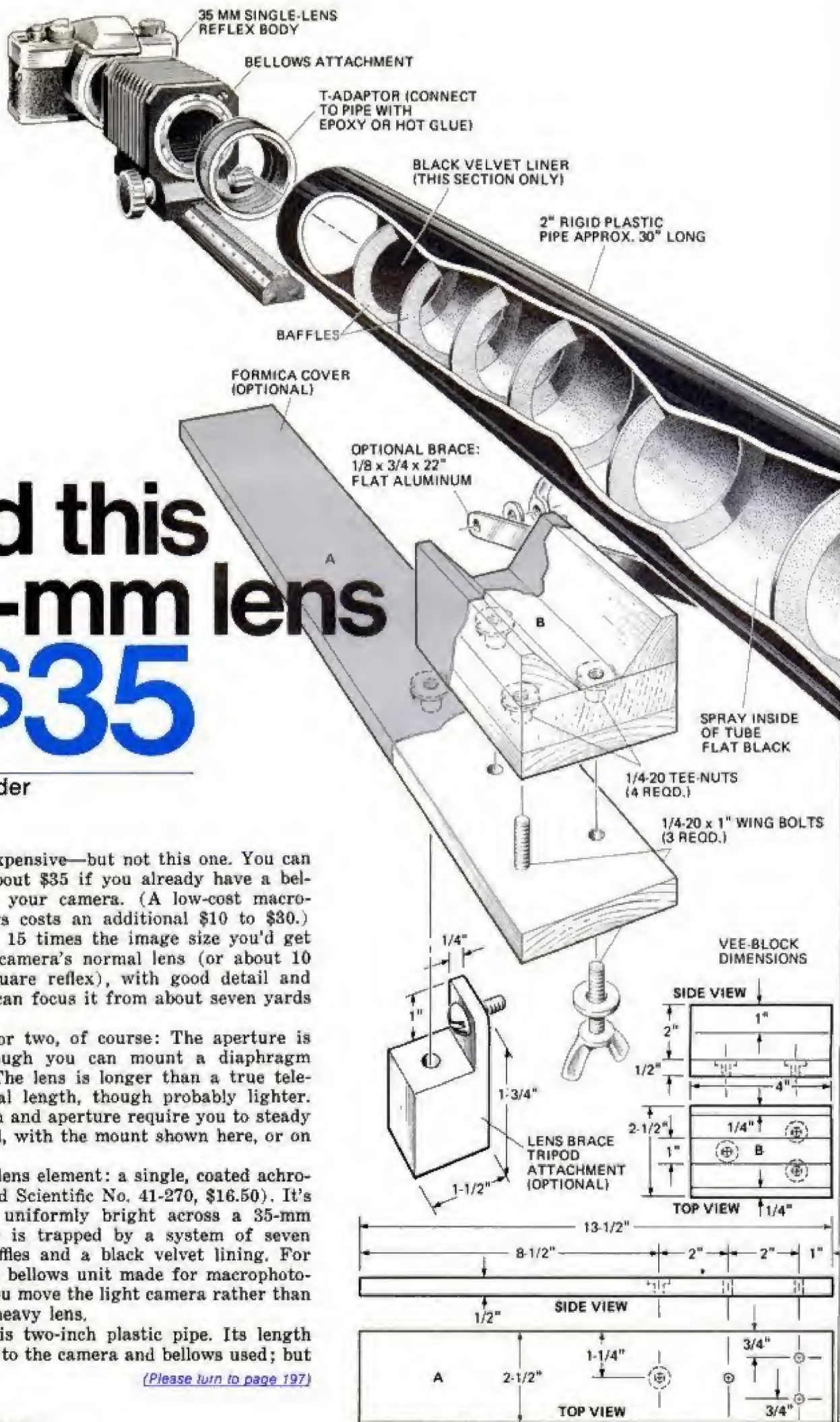
Long lenses are expensive—but not this one. You can build it for about \$35 if you already have a bellows accessory for your camera. (A low-cost macro-photography bellows costs an additional \$10 to \$30.) The lens gives you 15 times the image size you'd get from your 35-mm camera's normal lens (or about 10 times for a $2\frac{1}{4}$ -square reflex), with good detail and contrast. And you can focus it from about seven yards to infinity.

There's a catch or two, of course: The aperture is fixed at $f/16$ (though you can mount a diaphragm behind the lens). The lens is longer than a true telephoto of equal focal length, though probably lighter. And both the length and aperture require you to steady the lens on a tripod, with the mount shown here, or on bean-bags.

There's just one lens element: a single, coated achromatic lens (Edmund Scientific No. 41-270, \$16.50). It's well-corrected and uniformly bright across a 35-mm negative. The flare is trapped by a system of seven precisely placed baffles and a black velvet lining. For focusing, you use a bellows unit made for macrophotography. To focus you move the light camera rather than the comparatively heavy lens.

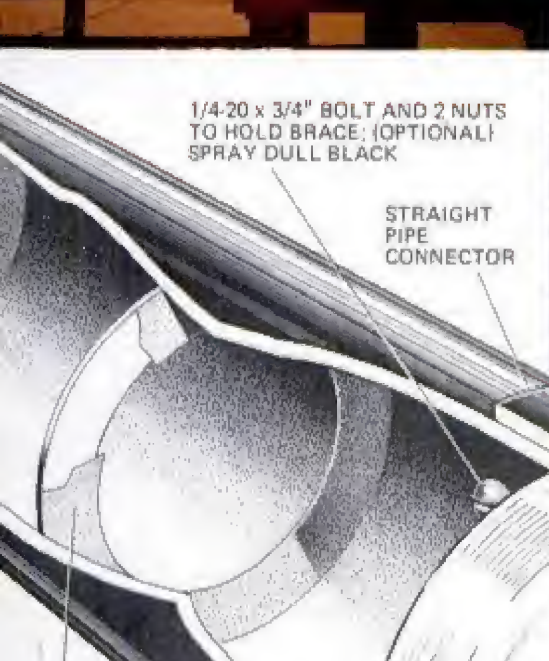
The lens barrel is two-inch plastic pipe. Its length will vary according to the camera and bellows used; but

(Please turn to page 197)





Super-long telephoto lens makes sun and moon loom large in photos at left. At bottom left are comparison views showing same aircraft-tower scene shot with normal lens and 762-mm tele. dramatically illustrating extreme magnification possible. In photo at bottom right, perspective is sharply compressed, a characteristic of such long lenses. Finished lens, shown in use below, is simple, attractive, easy to mount on tripod or beanbag rests to give it steady support.



1/4-20 x 3/4" BOLT AND 2 NUTS TO HOLD BRACE; (OPTIONAL) SPRAY DULL BLACK

STRAIGHT PIPE CONNECTOR

BAFFLE CONSTRUCTION : 2" ALUMINUM FOIL DISK WITH 1-3/16" DIA. HOLE OVER CARDBOARD DISC WITH 1-1/4" DIA. HOLE

LENS ELEMENT: 762 MM COATED ACHROMAT



The look of wood is great! Here are the simple steps to beautify your walls with paneling.

HOW TO WORK WITH PLYWOOD PANELING

by Harry Wicks WORKSHOP EDITOR

2

1

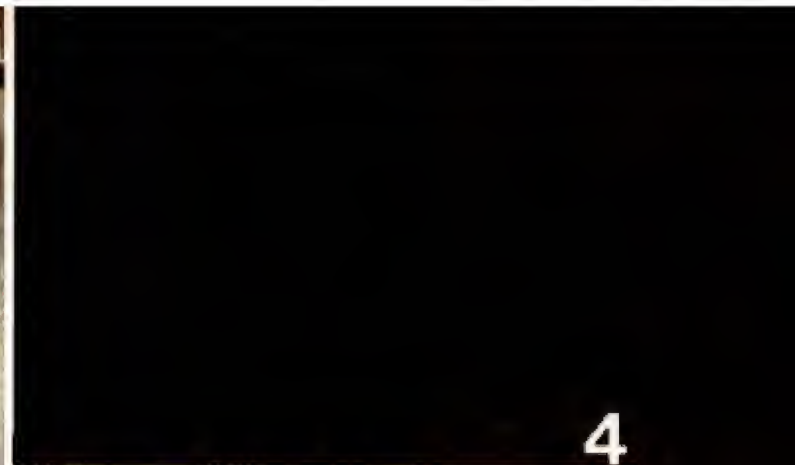


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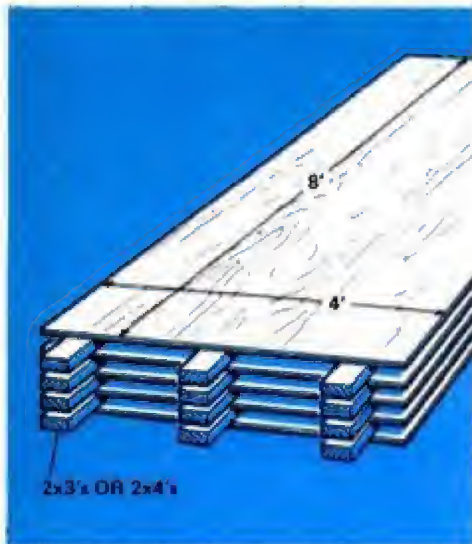
One of the surest ways to succeed when remodeling or redecorating is to cover your walls with wood. Paneled walls provide a surface that is compatible with all decorating styles, and there are now products available to suit just about any taste.

Paneling is a great solution because it is a one-time job. When the last piece goes up, you're finished for good. If you think paneling is beyond your skill, take heart. With some hitherto unpublished tricks used by the professionals, PM shows you how it's done on the following pages.



Available in wood tones and colors as well as smooth and textured finishes, wood paneling offers choices to create any mood. Prefinished panels were used in the rooms shown here. All are good examples of versatility possible with paneling: 1. Masonite's Coach House White; 2. U.S. Plywood's Weldwood Gothic Oak; 3. Weldwood Country Place; 4. Georgia-Pacific's Portsmouth Hemp; and 5. Weldwood Ticonderoga.

Preparing, fitting and cutting panels



Acclimate panels to room conditions by stacking for 48 hours before installing. Use spacers so air washes all surfaces.



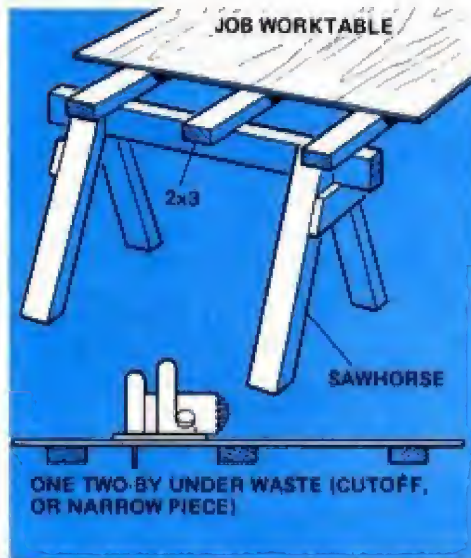
Stand sheets around room for best match of grain in daylight and artificial light. Then number panels to avoid a mixup.



Mark locations of all studs on floor and ceiling with lumber crayon or chalk before applying the first 4x8-ft. panel.



To start, measure from corner to center of farthest stud that panel reaches (here it is 39 in.); cut panel 1 in. wider (40 in.).



Good setup for cutting panels with portable saw: Table consists of a pair of sawhorses and three lengths of 2x3.



Plumb first panel using a spirit level. Temporarily tack panel up. Open scribes to 1 in., scribe the panel to abutting wall.



Cut scribed edge with plywood blade in sabre saw. Or use an 8-pt. crosscut saw that has little or no tooth set.



Leave line when you cut scribed edge; then carefully trim to the line using a block plane or Surform Shaver as shown.



Plumb the panel; temporarily tack it to check scribed corner. Next, run a pencil along edge to establish adhesive limit.

The how-to information given on these pages applies to all prefinished paneling whether it is plywood or hardboard (the latter is shown in photo 1, page 88). The only difference is that hardboard usually requires more patient handling because of its density. But it's that very density that gives this paneling a marproof resistance to bumps and bangs; hardboard is a good choice when you anticipate covering a wall that will receive rough treatment.

Sizes and thickness

Prefinished panels come in $\frac{1}{4}$ -in. thickness and 4x8-ft. sheets. In some woods, 7, 10 and 12-ft. sheets are available by special order. In recent years, many manufacturers have attempted to hold the price line by shaving the panel thickness—in some cases to a scant $\frac{1}{8}$ in. You should know, however, that high-quality paneling in full $\frac{1}{4}$ -in. thickness is still available from top manufacturers. Don't settle for less if you want a first-rate job.

Since each 4x8 panel covers 32 sq. ft. of wall area, you'll find that the work of paneling a room will go surprisingly fast.

Estimating your needs

Carefully measure the room you plan to remodel and be sure that your figures for windows and door openings are accurate. The easiest way to figure your needs is to add up the lengths of your walls in feet and then to divide this total by 4 (panel width). For example, if the room measures 12x16 ft., add $12 + 12 + 16 + 16$ to get 56. Divide this by 4 and you find that 14 panels are needed.

If there are a number of door and window cutouts, you may be able to use those leftover scraps to panel above and below windows and in other less-than-full-height areas. You can estimate this by planning to position a full panel *along the edge* of a large opening. To be safe, bring along a scaled floor plan of the room you want to panel and let your dealer double check your figures.

Preparing the walls

If the paneling is to be applied over bare studs, use a straightedge—a long 2x4 without any twist to determine

if any of the 2x4 studs aren't perfectly straight. If you find high spots, whittle them down with a hatchet or plane; low spots can be filled by shimming studs with shingles or folded 15-lb. felt. On new construction, you should staple a vapor barrier (6-mil polyethylene sheet) over exterior wall studs before putting up the panels.

In an existing room, start by removing all casings, moldings and other trim. If the walls are of plaster, it will be necessary to shim out the stud faces where baseboard has been removed. If any plaster is falling, remove it and patch the holes with plasterboard.

Remove plate covers from all electrical boxes and, if possible, free the boxes. These will have to be moved forward at least 1 in. if furring strips are used. They can be reinstalled using clips.

If plaster is in good shape—walls are sound and there is little variance in surface plane—install paneling directly over the plaster. Use plenty of adhesive and don't spare the nails either. Contrary to popular belief, it is a good idea to use a goodly number of nails—in the center of the panels as well as along their edges—even though panel adhesive is also used.

Furring strips are nailed horizontally to the wall and spaced 16 in. on center (o.c.). Use 1x2 furring strips—they're an inexpensive grade of pine—and fasten them by nailing directly into studs. To support vertical edges of the panels, position a vertical strip every 48 in. (or to suit panel width) from floor to ceiling. Apply furring around doors and windows as shown in the sketch at top of page 92. Where necessary, shim out the furring so that the faces of all strips are in the same plane.

The best way to get a smooth, good-looking wall is with your eye, not a spirit level. Put up all strips without driving the nails home, check the planes of strips using a straightedge and when satisfied, drive home all nails. Low spots can be shimmed (to the straightedge) using undercourse shingles; high spots are reduced either by chopping away plaster from behind a strip or planing down the furring.

Putting up panels

Start the job at a corner as shown on page 90. You'll find most corners are not perfectly true. Thus, you will have to scribe the first panel to the corner. To do it,



Apply adhesive liberally. Makers claim five-panels-per-cartridge coverage; professionals get two panels per cartridge.



Let panel contact adhesive, tack several nails at top, back-off panel and open for 6 to 8 minutes for solvent flash off.

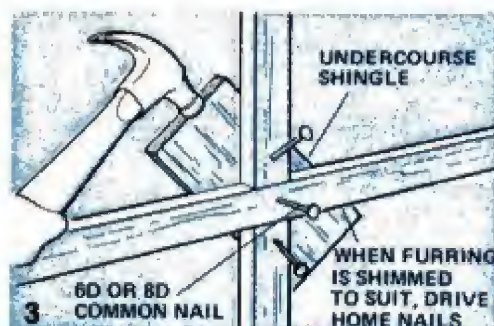


Finally, distribute adhesive evenly by sliding block of hardwood over surface while tapping continuously with hammer.

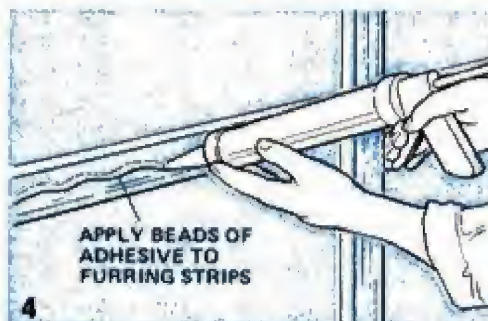
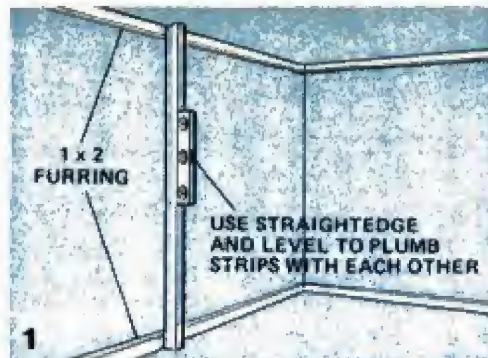
Working with furring strips

Apply furring strips at top and bottom of wall (right), then use straightedge and level to make certain they are in same plane.

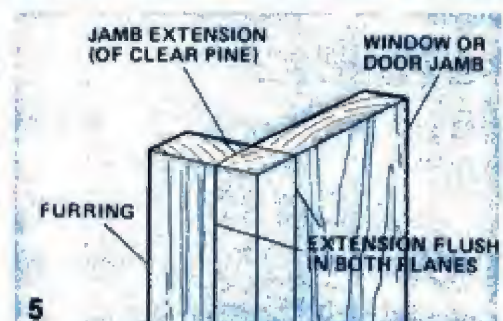
Run vertical furring strips to support panel edges (far right.) Horizontal strips are held by 6d common nails into studs.



Put all furring up without driving home nails. Then use straightedge to locate and shim out low spots as shown.



Apply beads of adhesive along furring strips. Install paneling over furring using same technique as for over walls.



When furring strips are over existing walls, window and door jambs must be extended as shown. Use clear pine here.

Fitting around windows



With helper butting panel against previously installed panel, mark the edges of panel above and below the window.



To determine height irregularities under window, measure between floor and jamb at right and left edges of 48-in. panel.



Transfer measurements to sheet back. To assure groove lineup, panel for area over window is cut from remaining piece.



Use 4-ft. T-square to connect measurement marks across full width of the panel. Next, mark offset of your saw's shoe.



Clamp T-square to paneling and use it as crosscut guide for a circular saw. Set blade depth to just clear 1/4-in. paneling.



Perfect fit, everytime. Nails used along top and bottom edges are located to be hidden by moldings, which will follow.

Two ways to make box cutouts



Popular, but not best, method—chalk is rubbed on face of box as shown here.



Hold panel in place, bang on face, and hope that an accurate line is transferred.



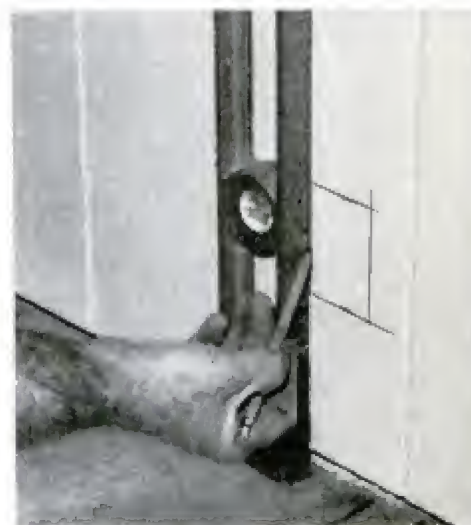
Instead, with spirit level, plumb and transfer vertical edges of the box to the floor.



Measure and record distances from floor to top and bottom horizontal edges of box.



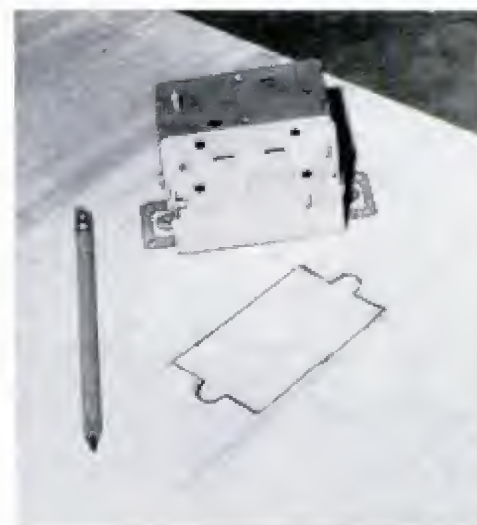
Temporarily tack up panel and mark these height dimensions on face of the panel.



Use spirit level to transfer the vertical edge marks accurately from the floor to panel.



Lay panel on sawhorse table finish side up; punch holes through at four corners.



Flop panel and locate gem box over holes; trace accurate opening to be cut.



Make plunge cut with sabre saw; complete cutout. See neat accurate fit (inset).

measure the distance from corner to the *center* of the farthest stud that a full panel will reach. On the job shown, that measurement was 39 in. Next, you add 1 in. to this measurement and cut the first panel to width; in this case, that made it 40 in. Then you hold the panel in

place, plumb it with a spirit level and temporarily tack it. Now, with your scribe (a compass works just fine) opened 1 in., transfer the outline of the abutting wall.

Take down the panel and with your sabre saw make

(Please turn to page 187)

Cities in the sky

This month scientists will meet at Princeton University to work out plans for a fantastic scheme to put entire human colonies into orbiting space habitats—in possibly the next 20 years.

by Richard Dempewolf

Imagine a huge cylinder four miles in diameter and about 16 miles long orbiting in outer space. Inside, you step from your cozy little cottage, stroll down a flower-lined garden path, wander through bird-filled wildlands, picnic in a forest park, swim in a lake, fish in a river. Later, you hop on your bicycle or in your tiny electric car and run down the street to the shopping center for some groceries.

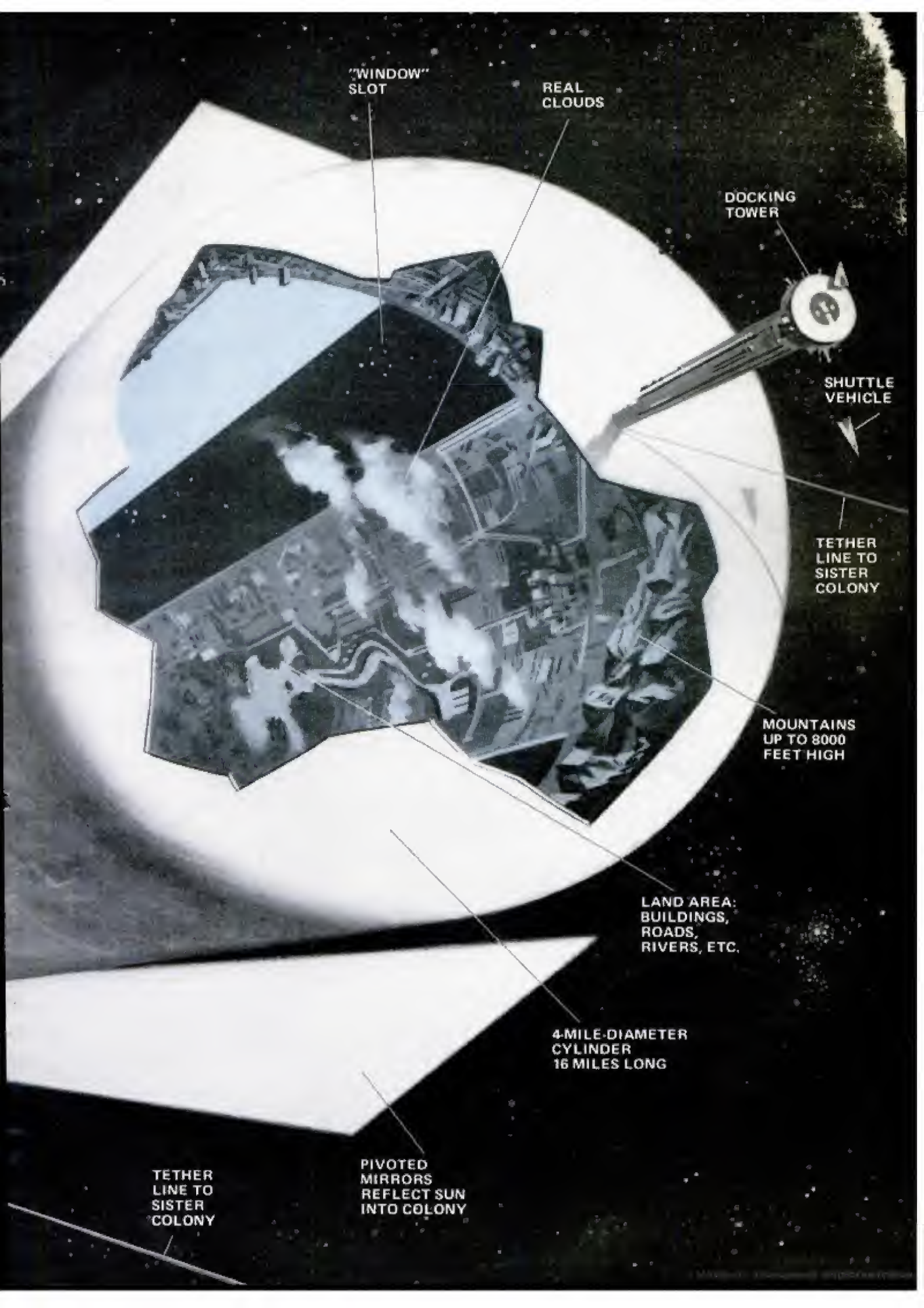
The cylinder will be rotating to produce artificial gravity, but you won't notice the motion. Everything will be just as it is on Earth—with a few pleasant exceptions. There will be no bustling crowds, no traffic jams, no blaring car horns, no ear-shattering sounds of heavy industry, no eye-smarting smog. The air will be clean and fresh and the climate perfectly controlled—except it may rain now and then for there are real clouds up in the "sky."

If you like mountain climbing, you can scale peaks up to 8000 feet high and—oddly enough—your backpack will get lighter and the going easier the higher you go because the artificial gravity decreases as you approach the center of the cylinder. And if you want to soar like a bird, just launch your pedal-powered glider from a hillside and off you sail—the lessened gravity at the "higher" altitudes will make man-powered flight easily possible.

There will be other strange effects, too. As you look across the four-mile expanse of the cylinder's interior, your neighbors' homes will appear



Art: Roy Grinnell



"WINDOW"
SLOT

REAL
CLOUDS

DOCKING
TOWER

SHUTTLE
VEHICLE

TETHER
LINE TO
SISTER
COLONY

MOUNTAINS
UP TO 8000
FEET HIGH

LAND AREA:
BUILDINGS,
ROADS,
RIVERS, ETC.

4-MILE-DIAMETER
CYLINDER
16 MILES LONG

TETHER
LINE TO
SISTER
COLONY

PIVOTED
MIRRORS
REFLECT SUN
INTO COLONY

upside down on the "roof." Water will run uphill. If it decides to rain, it will rain in all directions—up and down at the same time. Up on those mountains there will be special trick "low-gravity" swimming pools where you can dive off a board and take several seconds before hitting the water. When you aren't swimming, you'll be able to bask on beaches and get a real suntan from real sunlight streaming in through long, portlike slots in the sides.

If all this sounds like science fiction, it isn't. You're living in a man-made mini-world—a bold new plan to put entire human colonies into space. Not just orbiting space stations filled with antiseptic lab gear, but actual full-scale reproductions of Earthlike communities complete with houses, schools, stores, hills and valleys, trees and streams, roads and wildlife.

The project is not only feasible; it is under serious study right now. This month some 100 prominent physicists, engineers, astronomers, space-flight experts and other scien-

otherwise dull calculations more interesting by applying them to a glamorous, if theoretical, project. "As sometimes happens in the hard sciences," he observes, "what began as a joke had to be taken seriously when the numbers began to come out right."

The numbers indicated that completely self-contained, self-supporting, highly livable man-made mini-worlds could, indeed, be constructed in space—using *only* materials and technologies that already exist!

The initial prototype colony, O'Neill suggests, would be a small one supporting about 10,000 people. From this would eventually come full-size space communities with populations of 400,000 circling the Earth. If a decision is reached to begin construction soon, O'Neill estimates the first colony could be completed by the late 1980s—though you probably won't be able to move right in. It will take several years, using electrical power from solar energy, to get the gigantic cylinders spinning at proper speed. In any case, space communities *could* be ready by about the end of the century—in time for your children to be among the first space settlers in history.

Assuming free use of the present body of technical knowledge, projected cost of the initial prototype colony is comparable to that of the Apollo project—about 33 billion 1972 dollars. Within a few years, however, products and power produced in space would pay for the cost of construction, thus making such colonies financially self-liquidating.

For our own Earth, the environmental and ecological effects of space colonization will be staggering. It will take the pressure off our current population explosion. It will lessen the drain on our rapidly dwindling natural resources. It will end famine and disease caused by overcrowding. It will eliminate industrial pollution of our air and waters because manufacturing and power-producing plants will be moved from Earth to special "clean" facilities in the sky as part of the space-colonization program.

If O'Neill's proposals are followed, here are some likely prospects for the future: By the late 1990s or early 2000s, there would be no need for the construction of additional power-generation plants on Earth. Solar power stations in orbit would beam energy to Earth by low-density microwave, avoiding any need for nuclear power. By 2015, a significant fraction of all humanity would be living in space colonies. The population on Earth might even begin to decline. A thriving economic inter-

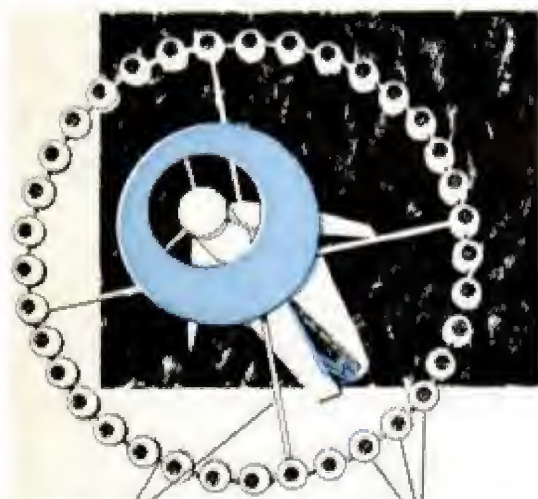
change between Earth and space would be established. By 2050, many industries now polluting the Earth's biosphere would have been moved to space factories, using pollution-free technology. Waste would be recycled, employing the unlimited low-cost energy available in the colonies.

With its population stabilized and pollution eliminated, Earth could become the "Garden of Eden" of the solar system.

Meanwhile, life in space will be much like it is here, with regular day and night cycles, natural sunlight, normal gravity and an Earth-



Princeton physicist Dr. Gerald K. O'Neill (right) explains his space colony plan to PM reporter Richard Dempewolff at left.



UNITS CONNECTED TO EACH OTHER AND MAIN BODY BY LIGHT CABLE

AGRICULTURAL, MANUFACTURING AND RESEARCH MODULES FORM 40-MILE-DIAMETER "HALO" AROUND END CAP OF MAIN COLONY

tists will meet at Princeton University to confer on realistic—not hypothetical—ways and means of implementing the plan. Organizer of the gathering and originator of the space-colony proposal is Dr. Gerald K. O'Neill, professor of physics at Princeton. O'Neill is a young, personable, dynamic, entirely hard-headed physicist who knows what he's about. "We can colonize space now," he says, "using 1970s technology. New techniques and approaches are needed, but knowledge and capability exist." He has data to prove it.

The space colony concept began as an "amusing" exercise for a group of ambitious physics students. The object, says the professor, was to make

like environment. All this will take place inside O'Neill's four-mile-diameter cylinders whirling around the Earth like satellite moons. The huge tubes will be pressurized to produce a "shirt-sleeve" atmosphere, and revolve to set up centrifugal forces simulating normal Earth gravity.

Actually, the cylinders will be arranged in pairs, tethered together by cables about 50 miles apart to insure precise orientation in space. The two tubes will counter-rotate, each canceling out any gyroscopic effect the other might produce, so the pair always remains pointed endwise toward the sun. The cylinders will each turn once every two minutes, powered by solar energy.

Outer walls of each cylinder will be divided into six longitudinal sections of alternating opaque and transparent material. The three opaque strips are "land" areas, built up with real rock and soil. Virtually any type of terrain can be simulated, from rolling Berkshire hills to sweeping western plains, a lush tropical paradise or lonely arid desert. Each land area is two miles wide by 16 miles long—big enough, O'Neill points out, to duplicate the south coast of Bermuda or the Carmel Bay area of California. In the prototype plan, an 8000-foot mountain profile copied from the Grand Tetons in

Wyoming is proposed as a surface for one cylinder end cap.

The alternating transparent panels, identical in size to the land strips, will admit sunlight. Three mammoth rectangular mirrors, hinged to open out above the transparent strips, will reflect the sun into interior land areas and make the sun visible to space dwellers just as it appears on Earth. By adjusting angles of the mirrors, it's possible to make the sun traverse the sky in an apparent dawn-to-dusk cycle and also to alter seasonal climates within the space colonies. You could even plan, suggests O'Neill, "a phase difference of seasons between the twin cylinders and have midwinter in one while it's midsummer in the other." Thus space colonists, visiting each other in small shuttle craft, could enjoy brief climate changes just as winter-bound Earthlings head south for a sunny retreat.

Almost nothing is impossible in the never-never storybook land of outer space. There is one problem, though—it's with stars. If you turn the mirrors away from the sun to reflect in the stars, the stars would appear to rotate every two minutes and "you'd get dizzy," O'Neill observes. But space dwellers will still get to see magnificent views of the

BUBBLE SEPARATES INTO TWO HALVES FOR REMOVAL OF EACH MODULE AS IT'S COMPLETED

RADIATION-PROTECTION LAYER



PRESSURIZED ALUMINUM "WORK" BUBBLE FOR CONSTRUCTION IN SPACE

INTERIOR OF BUBBLE PERMITS "SHIRT-SLEEVE" FABRICATION OF COLONY MODULES AT ZERO GRAVITY

stars from zero-gravity observatories and hotels just outside the habitat.

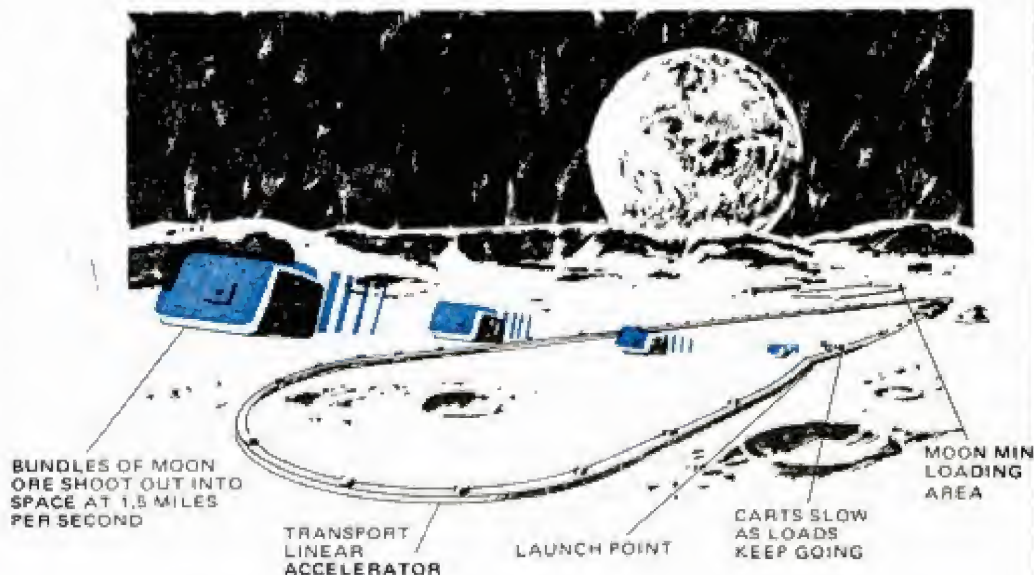
Crops will be grown outside the main cylinder in a "halo" of smaller cylinders or pods surrounding one end. The advantage of keeping agricultural areas outside, in addition to creating more living space inside, is that each one can be individually tailored to suit the specific things

you want to grow. According to Dr. Eric Hannah, O'Neill's right-hand man at Princeton, "In each of those outside cylinders you can change the climate and seasons to accommodate the crop. Each is a separate environment geared to citrus fruit, poultry, winter wheat, livestock—whatever you want."

Other external pods would be used to house industries, workshops, automated factories, scientific research labs, observatories and other special facilities. Thus all industrial, manufacturing and experimental work would be kept safely away from "civilization" in the main colony. As Hannah explains, "The external pods would be lashed in a space frame of light cable, probably, so they wouldn't run into each other. But basically they'd be independent units. That way, if there's a plant or animal disease, you can isolate the unit and sterilize it." Products produced in these external labs and factories could be sold to Earth, including some highly sophisticated things that are actually easier to make in space such as special crystals, supermagnets and other high-vacuum items. Power from satellite stations could also be sold to Earth.

The space colonies will circle the Earth along the same orbital path as the moon. The reason is curious. It has long been known there are five orbiting points in space where the gravitational forces of Earth and moon balance out. Any object stationed within one of these vast, roughly spherical gravity-less "pockets" would tend to be trapped there, orbiting Earth forever without need for propulsion.

These five gravity-free points, known as "libration centers," are designated "L1" through "L5". Areas L4 and L5 follow the same orbit as the moon—L4 ahead of it and L5 following it. Of the five centers, only



L4 and L5 are stable so these have been chosen as locations for the space colonies. The twin-cylinder space habitats would be strung out along these orbital paths at 120-mile intervals—far enough apart to be safely separated, yet close enough for easy access to each other. For intercolony travel, there would be public space shuttle "buses" making regular trips between habitats. To visit your nearer neighbors in your twin colony, you'd hop into an engineless, pilotless craft that can "unlock" from the outer surface of the revolving habitat at a preprogrammed instant and be flipped into space by centrifugal force at about 400 mph. In nine minutes, you'd "lock" onto the spinning adjacent cylinder at zero relative velocity. Docking towers and spaceports are at the "nose" of each cylinder to handle such craft, also space flights from Earth.

Most fantastic of all, perhaps, is the fact that these colossal colonies will not only be built in space, but will largely use material and energy sources found in space. Except for certain materials and special construction machinery needed initially to get the program started, only about two percent of all supplies will come from Earth, predicts O'Neill. Ore from the moon and asteroids, for instance, will be used extensively in fabricating parts of the habitats—at a fraction of the cost of moving the same materials from Earth. "To bring a kilogram of material from the moon to L5," says O'Neill, "takes less than five percent of the energy needed to move it from Earth."

To transport moon ore to construction sites in space, a unique device has been proposed. It takes advantage of the moon's vacuum and low escape velocity—less than a quarter of what would be required to boost comparable loads from Earth. This ma-

(Please turn to page 205)

IT'S NEW NOW



Instant anchor for a beach umbrella

Bikini-clad bathing beauties will have an easier time setting up their beach umbrellas with this invention from southern Italy. It consists of a separate socket (far left) containing a hand-cranked corkscrew-like bit that can be turned into the sand to provide a firm support. Once the anchor is in place, you simply slip the umbrella pole in the socket. The device is designed especially for use on hard, pebbly beaches where it's difficult to push an umbrella pole into the surface. It's the work of Antonio Fondocaro, Via Nazionale 129, Pellegrina Di Bagnare, Reggio Di Calabria, Italy. He hopes to have it on the market soon. That may please the girls, but pity the poor boys—now they won't have any excuse to come to the aid of "helpless" beach bunnies.

It's a plane ... it's a sub ... it's superboat!

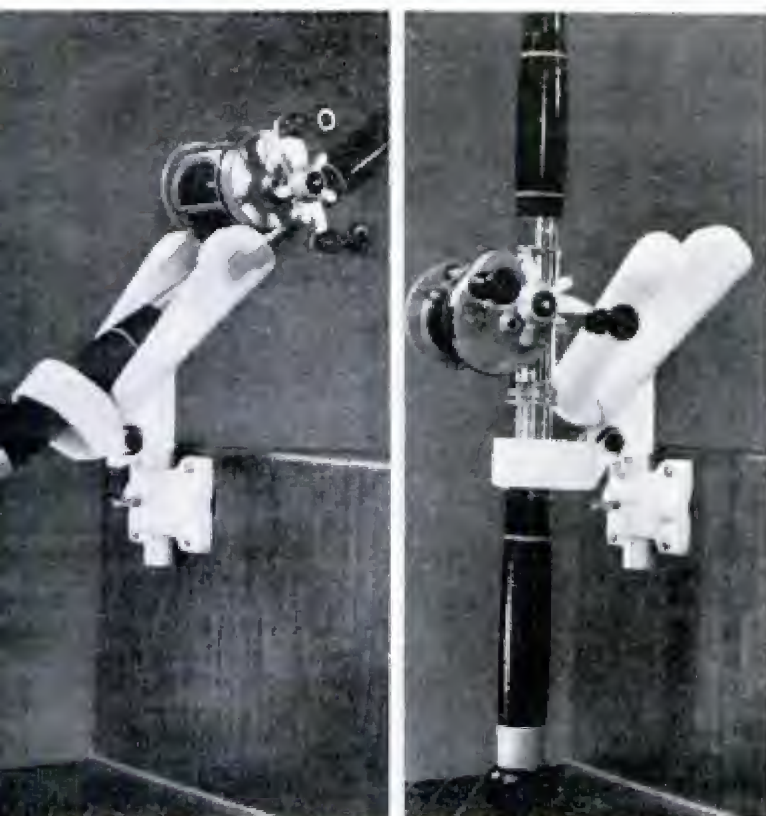
It looks like a cross between an airplane and submarine, but it's neither. It's a homebuilt speedboat designed by German mechanic Rolf Schmidt of Scheelsen near Hamburg. Unusual cigar-shaped hull is propelled by a pylon-mounted air prop powered by a 250-hp Volvo-Continental engine. It features an aircraft-type tail for stability with movable rudder to augment the water rudder for added steering control. Called FBS 100—for Flying Boat System and 100 kilometers—it has a top speed of about 62 mph.



Pedal your own paddle-wheeler

Air mattresses are fun to float on, but they're hard to maneuver and can even be dangerous if they drift or are blown too far out to sea. So thinks French inventor Nicolas Nalpas who came up with this lightweight paddle-wheel propulsion unit that can be strapped to most standard rubber rafts. Two versions are available—one you pedal like a bicycle, as shown at left, and one you operate by hand cranks. You steer by shifting body weight. Besides giving you water power, they're said to provide good, healthy exercise. They're made by N. Nalpas, 12 Vallée des Anges, 93 Clichy S/Bois, France.

THE LATEST PRODUCTS AND DEVELOPMENTS



Flip-up rod holder speeds hook setting, baiting

When you get a strike with this two-way fishing-rod holder, you can set the hook merely by pulling back on the rod. A pivoted ring (right) enables you to tilt the rod back without first having to remove it from the holder, saving valuable seconds. The ring also holds the rod upright for you, freeing your hands for easy baiting of the line. \$12.95 from Tempo Products Co., 6200 Cochran Rd., Cleveland, Ohio 44139.

He scoots through the water with the greatest of ease

Without moving a muscle, this scuba diver is propelled along at up to 3 mph. The reason for the apparent lack of power is that his propulsion unit, unlike conventional hand-held models, attaches directly to his air tank, leaving his hands free. New battery-powered Scuba-Drive is about \$200. Shakespeare Products Div., Kalamazoo, Mich.



Quick-change camping carrier is bike pannier or backpack

In 30 seconds, you can convert this double-duty Trek Pak luggage carrier to either bike pannier or backpack. Made in three sections, it unfolds to fit over a bike carrier and straddle the rear wheel (top photo). Zipped together, the sections become a single unit for use as a backpack with shoulder and waist straps (bottom). Price not announced. For information, write Pawtucket Foam Products, 390 Pine St., Pawtucket, R.I. 02862.



Washing brush has swiveling head

Wash-Master, all-purpose wash-brush kit, pours out a rush of suds or clear water for cleaning cars, trucks, campers, boats, windows, siding. Brush head is 8½ in. long by 3½ in. wide, has nonscratching plastic bristles. It swivels and locks in either wide position or torpedo setting for corners. Automatic sudser in 41½-inch handle has pushbutton control, attaches to garden hose with a Cyclac fitting. Suggested retail price is \$16; Manufactured by Pyroll Master, 445 West Nixon St., Savage, Minn. 55378.



Cold-beverage server fits inside refrigerator

For easy storing and dispensing of cold beverages, Baysee KoldPor KP-6 is a sturdy 6-quart container with faucet. Made of polyethylene, it safely holds almost any kind of liquid without damage or transfer of flavors, and is easily cleaned with soap and water. KP-6 fits on standard refrigerator shelves with its faucet overhanging, so that youngsters can serve themselves drinks without spilling. Its dripless faucet has two operating positions—for automatic shutoff and continuous flow. Price is \$7.85 postpaid from Baysee Products Co., 1341-V East Fulton St., Grand Rapids, Mich. 49503.

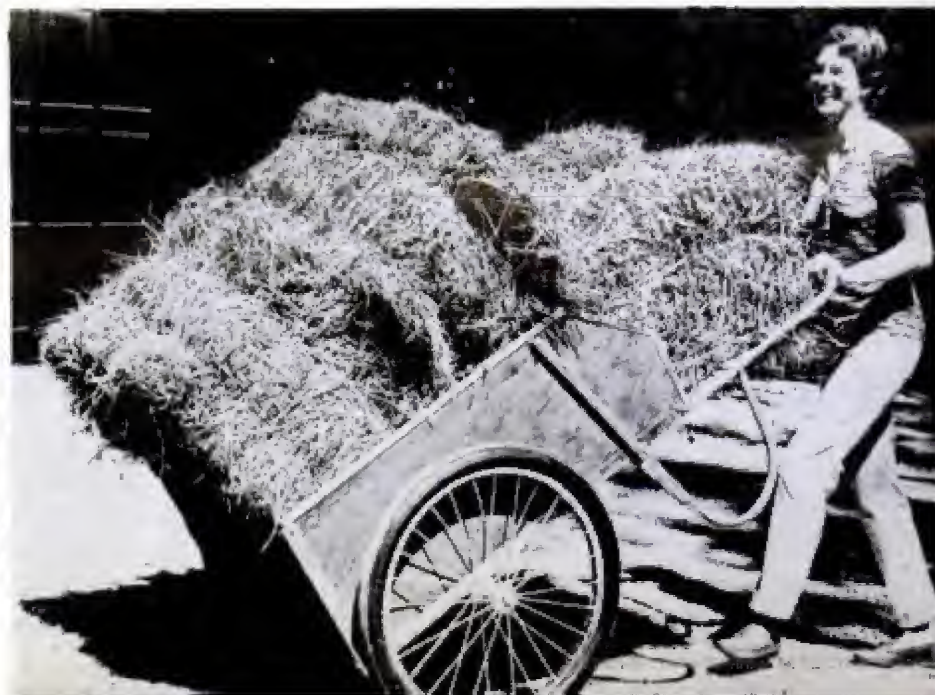
If you don't answer this phone, help comes fast

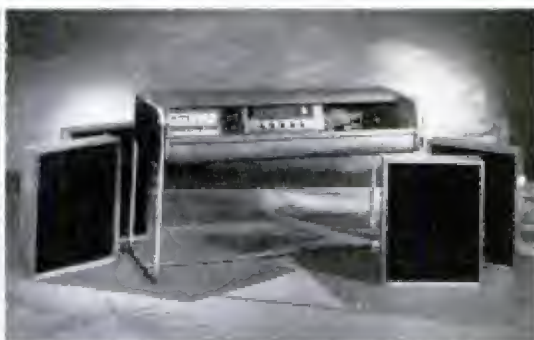
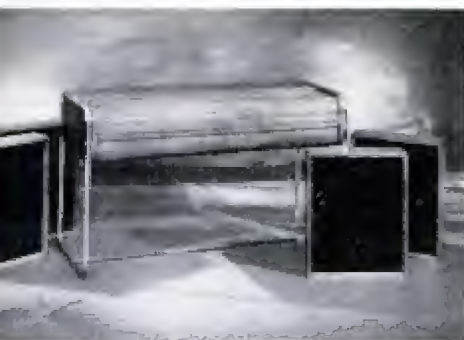
Your telephone can keep tabs on the ill or aged in a new system called Phone-Care. The phone is programmed to beep and flash at preset intervals. If the patient is unable to respond by shutting it off, it automatically dials up to five emergency numbers—and keeps dialing until help arrives. The patient can also dial the numbers remotely by pressing a portable switch. M.E.D.I.C., Inc., Scott's Valley, Calif., developed the system.



Jumbo garden cart carries large, heavy loads in single trips

For big yard and garden jobs, Garden Way Model 26 cart has a capacity of nearly half a cubic yard and up to 400 pounds. Large 26-inch ball-bearing wheels with balloon-type tires roll readily over obstacles. Load is balanced over axle for easy pushing and pulling. Track width and height let cart straddle garden rows; handle telescopes to suit user. Construction is ½-inch plywood with steel on all edges. Stores upright. \$119.50 plus shipping; Garden Way Research, Charlotte, Vt. 05445.



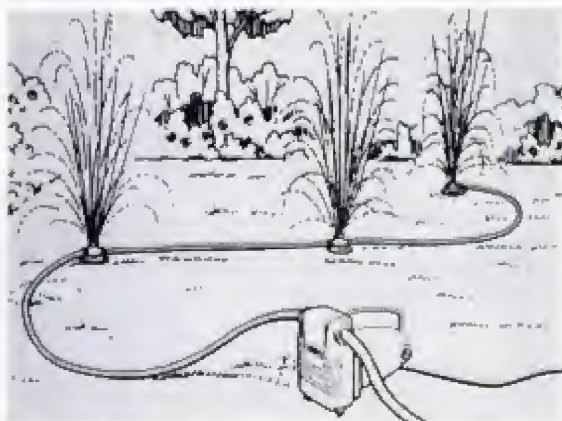
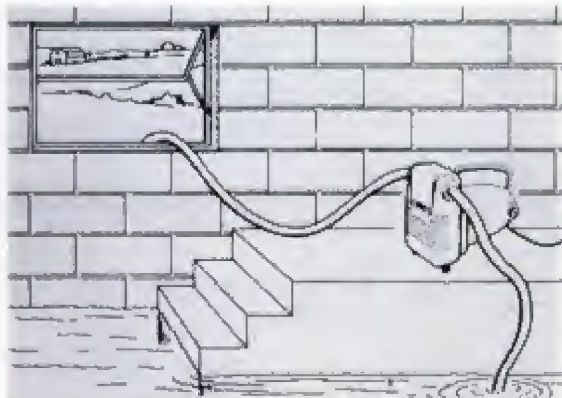


Modern rolltop is hi-fi set

This modern piece of furniture isn't a rolltop desk—it's a rolltop 4-channel radio/phono/8-track console. Each of its four speaker systems has a separate woofer and tweeter. Its 4-channel decoder section gives quad sound from SQ records and FM broadcasts, simulated 4-channel sound from stereo. In chrome, pecan and black, it's \$750. Magnavox, 345 Park Ave., New York, N.Y. 10022.

Lightweight utility pump for home and garden use

Weighing 12 pounds, Minute Master pump can move more than 1300 gallons an hour. Self-priming pump has ½-hp motor, runs on house current; 40-p.s.i. output can operate three sprinklers—couplings accept garden hose. About \$85; optional kit with 15-foot hose and flat suction nozzle to drain flooded areas, \$17. Peabody Barnes, 651 North Main St., Mansfield, Ohio 44902.



This—believe it or not—is a toy!

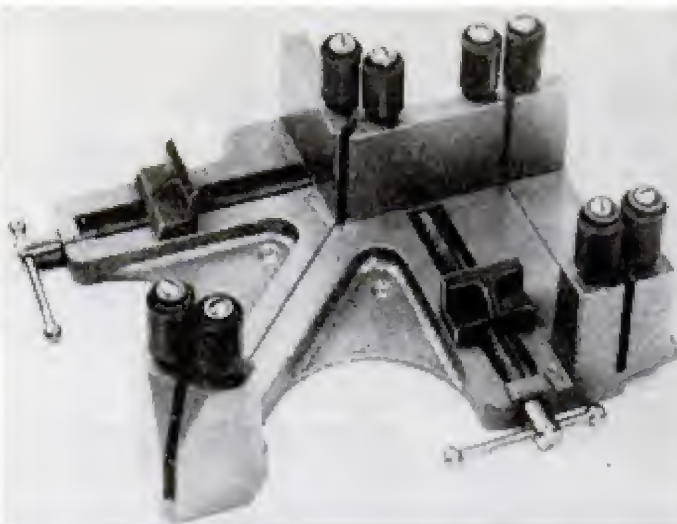
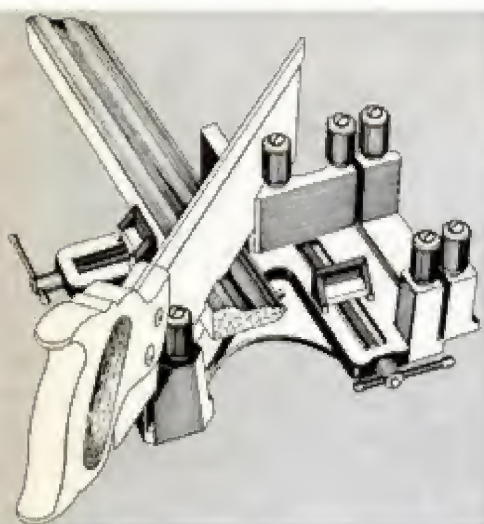
You have to look twice to tell this tractor cab isn't the real thing. The beautifully detailed scaled-down replica was built by Bruce R. Branch Jr. of Martinsville, Va., for his three sons. It's 8 feet long, 40 inches wide, is powered by a 7½-hp engine from a riding mower, has three forward gears and reverse. Top speed is about 15 mph. All lights, horns and other accessories really work. There's even a 14-foot flatbed trailer to go with it.

Cordless trimmer cuts wide swath through big jobs

Wide Tracker cordless electric grass trimmer fills the gap between small trimmers and mowers. Suggested for awkward lawn alcoves, light weed-growth areas, steep banks and hard-to-reach trimming areas. It cuts a swath nearly a foot wide. Squeeze-lever switch is located on 40-inch adjustable handle, has safety lock. Battery pack delivers 30 minutes of operation on a charge, with trimmer making 28,800 cutting strokes per minute; extra battery packs available. Weight is 11 pounds. Suggested retail price, \$69.99. Disston, Inc., 601 Grant St., Pittsburgh, Pa. 15219.



NOW



Miterbox with roller guides

Clamp-N-Saw miterbox can be used with either backsaw or handsaw to make perfect 45° and 90° cuts, maker claims. Roller guides adjust for saw's thickness; movable jaws, hold workpiece firmly. After mitering, Clamp-N-Saw holds pieces for gluing or nailing. Frame is heavy cast aluminum, can be bench-mounted or used freehand; accepts workpieces up to 4 inches wide, 2 inches high. \$18.50 at hardware stores. Durall-Eagle Tools, 923 Old Nepperhan Ave., Yonkers, N.Y. 10703.

Adjustable camera bag gives you a lot of choices of equipment to carry

Here's a good-looking camera bag (right) that boasts a few nice extra features not found on the average gadget toter. The adjustable partitions—and the optional additional camera cradle shown in the foreground—give you a choice of carrying one or two 35-mm cameras, plus just about any likely combination of lenses, flash, film and other accessories. For bigger cameras, the sectioned compartment lifts out altogether. Double handgrips and a snap-on shoulder strap make for easy carrying. The bag is priced at \$50 to \$55, depending on options chosen, from Spiratone, Inc., 135-06 Northern Blvd., Flushing, N.Y. 11354.

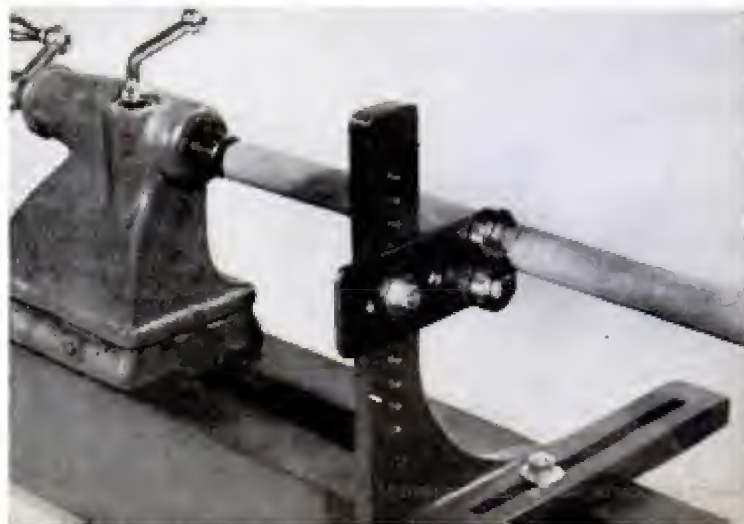


It's now 79° outside—and if you wait four seconds, this new Heathkit will show you the inside temperature, too

No more squinting at thermometers, or sticking your head out a window to see what it's like outside. This new Heathkit shows you the temperature digitally from -40° to +120°F., or -40° to +50°C. It can be set to show either inside or outside temperatures or to alternate, every four seconds, between them. Building time was 11 hours. Style matches Heath's CC-1005 clock (page 127, Dec. '73). Price, including 85 feet of cable for two temperature sensors, is \$63.

Ball-bearing steadyrest reduces vibration without marring turnings

For lathes with 6 to 17-inch swings, this steadyrest turns with the workpiece at support points and minimizes vibration and chances of breakage with even long, very small-diameter turnings. It won't burn or mar workpieces as a friction steadyrest can. Ball bearings are factory greased and sealed. The design permits support at any point along workpiece. \$38.50 postpaid, from Turn-O-Carve Tool Co., Box 8315, Tampa, Fla. 33604.





Lightweight table saw with a hefty cut

This Toolkraft Model 91 table saw is designed to offer quality features at a modest price. It has a $\frac{3}{4}$ -hp motor, 9-inch blade, double-locking rip fence, meter gauge, ball bearings throughout and 17x20-inch table. Still, total weight, with motor, is only 49 pounds. \$164.95. Also available is Model 91K with extra-large 20x35-inch table for \$229.80. Toolkraft Corp., Plainfield St., Chicopee, Mass. 01013.

Take-it-with-you water filter fits any faucet, home or away

This small, portable water purifier slips over any faucet, can be carried with you on camping trips or foreign travels to provide clean, fresh-tasting water. Containing activated charcoal, it's said to filter out bad tastes and odors, chlorine, dirt and other impurities. (Note: Not intended for removal of dangerous bacterial contaminants, however.) \$3.95 postpaid, Three Sons Unlimited, 245 East Gunhill Rd., N.Y. 10467.



No-sweat, no-slip bow stringer for archers

This handy aid is said to eliminate the hardest part of archery—stringing and unstringing the bow. Standing on the line and pulling up springs the bow for easy slipping of bow string into or out of tip notch. Unlike some earlier types, there's no end cup to cover and obstruct the notch. Instead, a nonslip plastic gripper loop holds the bow tip securely while leaving the notch exposed. No-Twist Bow Stringer is \$2.95 at sports stores or from Saunders Archery Co., Box 476, Columbus, Neb. 68601.

Sound waves tickle dirt away in this kit-built ultrasonic cleaner

Cleaning objects full of intricate, dirt-catching cracks (such as paintbrushes, jewelry, watch parts, dentures) is easy with this Heathkit GD-1150 Ultrasonic Cleaner. Fill the stainless-steel tank with detergent or solvent and 41,000-Hz ultrasound waves agitate the solution into every nook and cranny. A timer shuts it off after one to five minutes. Building time is two evenings; price, \$55. Our test sample (right) proves it works—cleaned half of gear wheel is bright; uncleaned half, black.





Netronics, N1000X, \$90

Heathkit IC-2100, \$120

Sinclair Scientific, \$50

MITS 7440, \$200

Super math from simple kits

Four new calculators that match your math skill and put-together know-how.

These four electronic slide-rule kits offer surprising variety, though all do basically the same kinds of trigonometric, logarithmic and arithmetical calculations.

Least typical, tiniest, cheapest and quickest—if not easiest—to build (1 to 3 hours) is the Sinclair. With features like fixed scientific notation (that shows numbers as five significant figures plus a power of 10 to save displaying unnecessary zeros), reverse Polish notation (see Dec. '74, page 168), and trig functions that only work in radians, not degrees, it's strictly intended as a slide rule, not for household math.

The Heathkit is more home-oriented—easiest to build (but it takes nine hours), with easy-reading display showing only normal, not scientific notation, and slick styling.

Features abound in the Heath, MITS and Netronics kits: All three have keys that enter pi to 8 digits (Heath) or 10 digits (MITS, Netronics) with a single stroke (two, on

the Heath). All three have keys that do direct square roots, raise numbers to any power (handy for finding cube and complex roots), change numbers from positive to negative and back interchange factors, that find base-10 logs, natural logs, powers of *e* and reciprocals, and keys that perform trig calculations in radians or degrees.

Functionally, then, the main differences between the Heath and the other two with precisely the same functions lie in memories. Heath has one memory, with four keys to clear, read or add to the memory or to exchange the number held in memory with the one on the display.

The MITS and Netronics have two extra registers: One is a memory with a single key that either enters the number on the screen into the memory if it's a total, or displays the memory's contents if anything but a total is on the display. The other is a pair of parentheses which can enclose a subcalculation within a larger one. The MITS and Netronics also have one key for every function; the keyboards of the other two have shift keys that let one key perform two functions (Heath) or three (Sinclair), according to the shift key position. Building times are about seven hours each for the Netronics and the MITS.—*Ivan Berger*



Single, 42-pin integrated circuit helped to make the Heathkit IC-2100 the easiest, if not the quickest, to build.

Driving Cadillac's brand-new Seville

by Michael Lamm
WEST COAST EDITOR

Photos by the author



Comparative Specifications

	1975 Cadillac Seville	1975 Chevelle Malibu V8	1975 Cadillac Sedan de Ville
Wheelbase, in.	114.3	112.0	130.0
Overall length, in.	204.0	205.3	230.7
Width/height, in.	71.8/54.7	76.6/53.1	79.8/54.3
Standard V8, c.i.d./bhp	350/180	350/145	500/190



Who says Detroit can't engineer big-car silence and smoothness into an intermediate? Cadillac has done it, and they call it the 1975 Seville.

Earlier this spring, I got a chance to drive an early-production prototype—one of six then in existence—at GM's desert proving grounds near Phoenix. Here are some of my initial impressions:

The car moves away from a standstill with barely a whisper, and it's marvelously quiet at any speed. Lapping GM's five-mile oval test track, I thought I was cruising about 55 mph, but when I looked at the speedometer, the needle registered 80. It's a silence that takes getting used to.

And the Seville doesn't ride—it *glides*. It's glass-smooth, yet the suspension is firm enough so there's

hardly any lean in sharp turns. Handling is one of this car's very strong points: quick, precise, predictable. My only minor objection is the steering wheel itself. Sharp ridges between the spokes and the rim make one-finger parking painful.

The Chevelle-sized Seville uses a K-body, which it shares with no other GM car. Early rumors had it that the Seville would use the Nova/Ventura/Omega/Apollo X-body, but not so. Actually, the K-body is quite a bit different. Wheelbase is 114.3 in., overall length is 204.0 in., width is 71.8 in., and height is 54.7 in.

It's unitized, with a front subframe to carry the engine and suspension. To hold down front-end sheet-metal flexing, two tubular shock absorbers help tie the front subframe to the inner fenders. This is the first

time I've seen such an arrangement, and I know that on my Camaro, which uses the same basic wheelbarrow construction, the front-end sheet metal does undulate in directions quite opposite from the rest of the body. I suspect that would happen in the Seville, too, if it weren't for those linking shocks.

Cadillac engineers used a whole bag of tricks to tune out vibrations and road harshness. They've put Teflon liners between the Seville's rear spring leaves plus rubber spacers atop the front coils. Shocks use a chambered design to keep the hydraulic fluid from becoming bubbly. The Seville also has rubber-bushed links in springs and stabilizers, a sound-absorbing link between the transmission and the body, tuned

(Please turn to page 204)



Glue strips together and clamp when two or more moldings are combined.



Stand molding upright in the miterbox to cut either right or left 45° corners.



Make the initial miter cut, then measure along rabbet, mark and cut second miter.



Apply glue, clamp corner, wipe off excess, nail from both edges and set nailheads.



26 fun-to-make picture frames



With more than 250 patterns and 400 sizes to pick from, there's literally no end to the many attractive picture frames you can make from stock lumberyard moldings. You can spot many such moldings by looking at the trim around doors and windows and along the ceilings and baseboards of your home—they're all common shapes normally used in house construction, inside and out. Known as drip cap, bed, casing, cove, crown and so on, these decorative and pleasing shapes of ponderosa pine can be your "building blocks" to picture-framing fun at a cost far less than that of regular picture-frame molding.

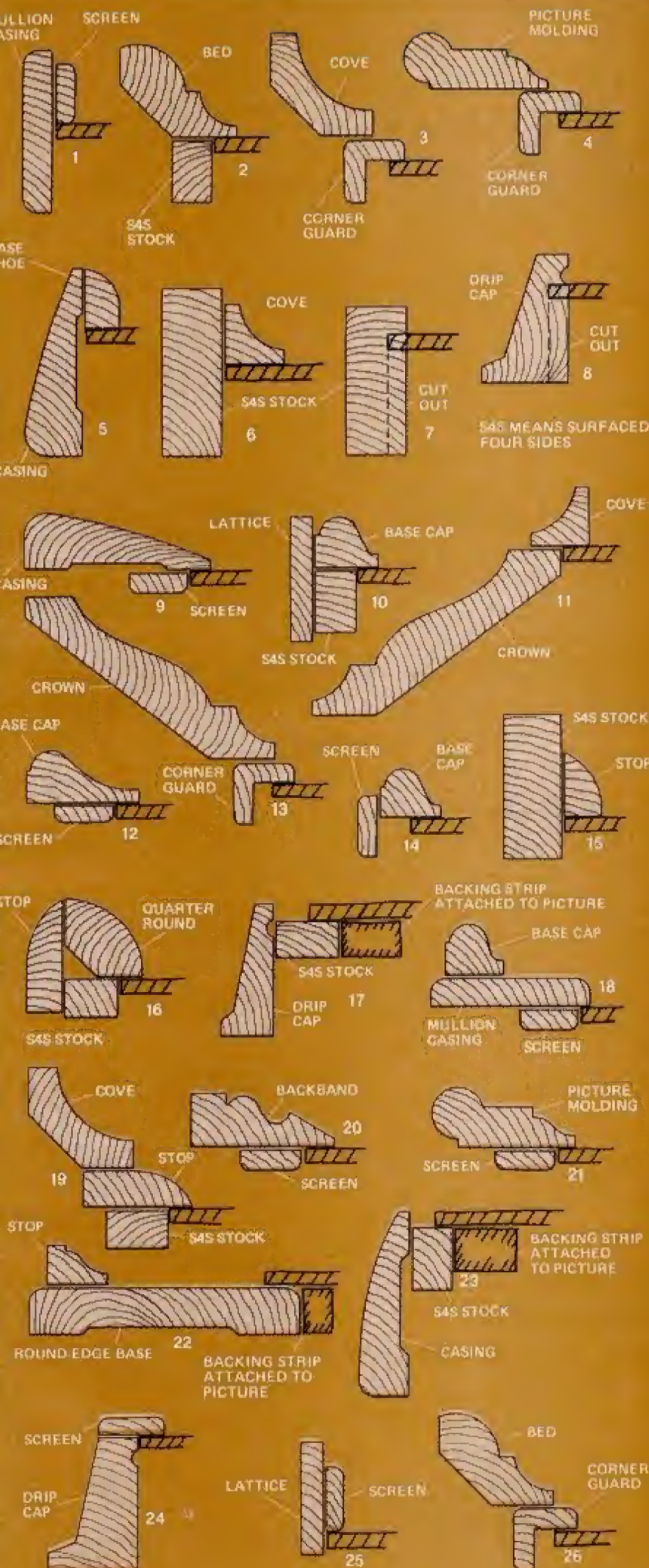
Illustrations at the right show only 26 of the many different attractive frames you can create by using

the molding alone or in combination, and the grouping above is an example of how you can mix and match your frames in never-ending combinations to create dramatic and exciting picture walls.

Aside from such tools as a light hammer, nailset and fine-tooth saw, you'll need a miterbox and a corner clamp or two. The latter makes it easy to hold the mitered ends for nailing. The trick to mitering the molding to the right size is to measure along the glass rabbet on the back, not from corner to corner. Add $\frac{1}{8}$ in. to the measurement for an easy glass fit. Remember also that bed, cove and crown moldings must stand at a 45° angle in the miterbox for mitering, and that opposite ends must be cut right and left-hand.

You can get detailed information for finishing your frames, as well as ways to group them, by writing Western Wood Moulding and Millwork Products, Box 25278, Portland, Ore. 97225.

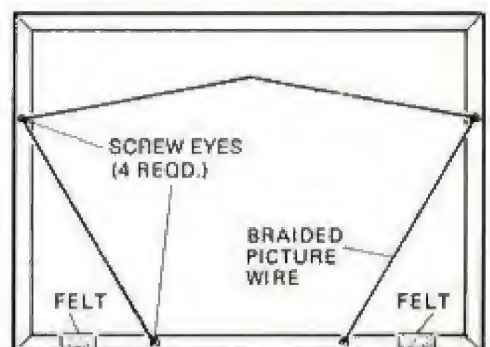
Sand completed frame lightly, then stain or paint the molding as desired.



How to hang your pictures to stay

Pictures add a lot to any home, but if they're not hung properly—CRASH! Hangers should be selected according to weight and size of the picture. Lightweight (12-oz.) pictures can be hung with gummed adhesive-tape picture hooks. Sawtooth hangers will do for small and medium-weight (2-lb.) pictures and are attached to the frame with small-head nails. Decorative hangers come in many styles and sizes and are screwed into the top of the frame or nailed or screwed to the back.

Screw eyes and braided wire work well for medium and heavy (5-lb. or over) pictures. Braided wire is stronger and more flexible than single-strand wire. Screw eyes should be placed about one-third down from the top of the frame. If they are too far down the frame, the picture will tip forward from the wall. For greater strength, loop wire through each screw eye twice and twist the ends around the cross-wire. A wire that's too slack will show above the frame; if too tight, it will cause the picture to slide on the hanger and be uneven on the wall. Small felt pads glued to the frame bottom will



protect the wall and provide ventilation behind the picture.

The four-screw-eye arrangement diagramed above is especially good for heavy pictures; most of the weight is supported from the bottom, yet the two side screw eyes keep the frame from tilting.

For wall use, the simplest hanger is the J-shaped picture hook nailed at a 45° angle. While it's better to locate a stud in hollow walls, this hanger will hold well in plaster or paneling and can support as much as 100 lbs. For a large picture, two hooks offer greater strength and will help keep it straight. Masking tape applied to the spot where a hook is to be nailed into plaster will help prevent chipping.

Gummed adhesive-tape hangers

(Please turn to page 199)

By Resolution of the U. S. Senate: "MAY IS CAR CARE MONTH"!

Recognizing that proper car care is important to both the ecology of the country and the safety of its citizens, the United States Senate has unanimously resolved that the month of May be designated "National Car Care Month."

Senator Carl T. Curtis (Neb.)

introduced the resolution pointing out that more than 5,000 lives could have been saved on our roads and highways in 1974 if proper car care had been observed by drivers. In addition, proper maintenance would have an important and salutary effect in enhancing our air pollution standards. Well-planned and executed programs in Nebraska have earned for the state the nation's best automotive safety record.

The resolution calls upon the people of the United States and interested groups and organizations to observe the month of May with appropriate activities and efforts to maximize road safety by encouraging conscientious care and maintenance of automobiles. Senator Curtis and Congressman John Y. Mc-

Collister (Neb.) have also called on all 50 state governors to proclaim Car Care Month in their states. In conjunction with this Resolution, Popular Mechanics has once again teamed with the Automotive Parts and Accessories Association (APAA) to sponsor the 3rd annual "May is Car Care Month" program. All across the nation, thousands of automotive retail outlets will be actively involved. The Popular Mechanics and APAA symbols in advertisements and in-store displays will help you identify the car care products featured throughout the entire Car Care Month. To help you even more you'll find a directory of participating dealers in the following pages.

THE 1975 CAR CARE GUIDE! A THIRD BIG YEAR OF HELPING CAR OWNERS SAVE TIME AND MONEY!

Beginning on the facing page is the '75 Car Care Guide. It's a magazine-within-a-magazine that's packed with do-it-yourself automotive information

and car care tips—the kind of valuable, up-to-the-minute know-how that can save you time and money on car maintenance and repair bills.



You can remove the Guide as a unit by bending the remaining pages of the magazine back and pulling the Guide loose from the binding. Keep it in your glove compartment for handy reference.



Look for the stores and products displaying the APAA's Symbol and Popular Mechanics Product Feature Mark



Popular
Mechanics'
1975

CAR CARE GUIDE

Big special
section
prepared by
the editors
of PM!

All the expert
know-how
you need
to keep your
car looking
better and
running
smoother
mile after
mile after
mile

IS IT A MIRACLE?
IS IT FROM ANOTHER WORLD?

IT'S **DURO** WOODHILL

SUPER GLUE•3™

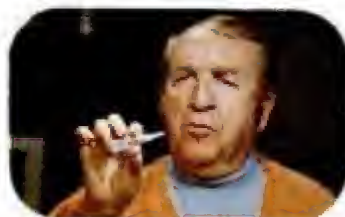


SUPER FAST!

Bonds steel in seconds. Yet, it's gentle enough to mend china so that you can never see the break.



One drop, in less than 10 seconds, bonds bumper strips, car trim, vinyl upholstery, jewelry, glassware, loose knobs, luggage locks and hundreds of other things on your car, in your home and on your boat.



This is the glue you've seen on TV.
This tube is made of metal so the SUPER GLUE•3 inside will last and will not harden.



SUPER STRONG!

One drop can hold 5,000 pounds! That means one drop could lift two full-grown rhinoceri.

150

As many as 150 applications in every tube. One drop is all you need.

SUPER GLUE•3 is a cyanoacrylate developed by Loctite technology.



Look for DURO wherever hardware and automotive products are sold.

DURO WOODHILL

© Woodhill 1975

CAR CARE GUIDE



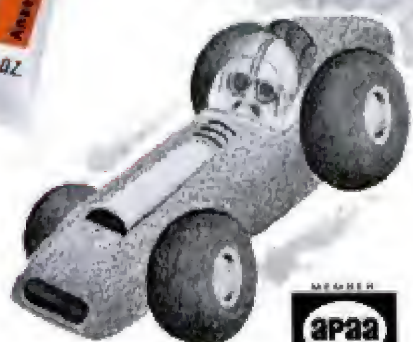
LOCK-IT™ will keep your car in one piece!

LOCK-IT takes the place of lock washers. It stops nuts, bolts and screws from loosening. Not even vibration on the worst road will undo them. Just one drop is all you need. LOCK-IT also seals against leakage and corrosion. Use LOCK-IT on lawn mowers, bicycles, eyeglasses, tools, auto mirrors, and on other nuts and bolts that may loosen.



Over 150 applications in every tube. That's a lot of mileage.

LOCK-IT has been used for the past 15 years at Indy, stock, drag, cycle and marine courses throughout the world. Car manufacturers use it at the factory on your car's nuts and bolts. Now, at last, you can buy it at your favorite store.



Another fine product developed by Loctite technology.



World's Finest Fix-It Products
Woodhill Chemical Sales Corp.
Cleveland, Ohio 44128

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PM's clean machine

How to use PM's
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Section 3. Electrical
and ignition systems

Section 4. Suspension
and steering systems

Section 5. Wheels
and tires

Section 6. Braking
system

Section 7. Your car's body

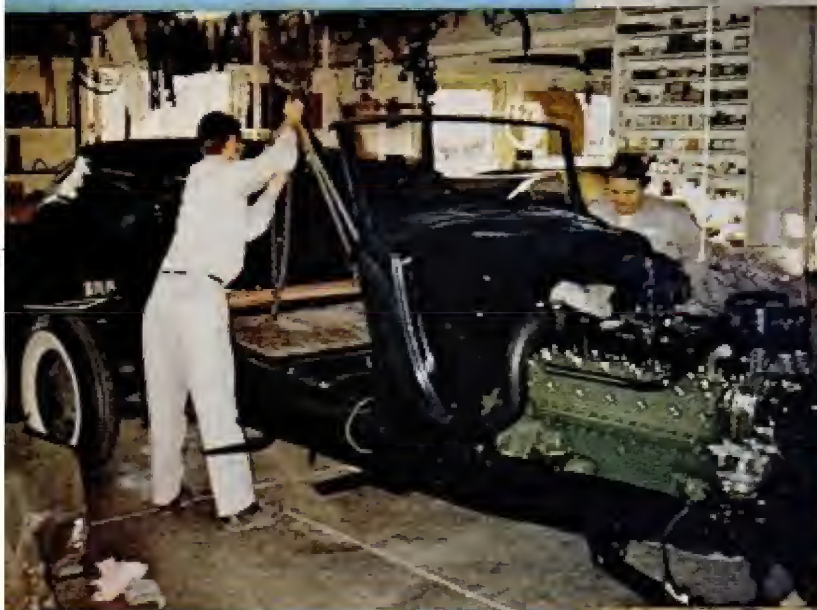
Travel safe

Prepared by the editors of Popular Mechanics
with technical art by Peter Trojan,
PM's Clean Machine by Dale Gustafson

CAR CARE GUIDE

HOW CAR CARE PAYS OFF

Tender loving care (TLC) is the kind of car care that keeps your wheels new. If your car is older and a bit beat up, you may have to do major work to resurrect it. If you're a real enthusiast, a professional restoration job on a classic could be a wise investment. Be your car new, used or antique, the information in the following three sections will help you save money and run longer.



Restorations are costly, but, when done professionally on the right choice of car, are a wise investment. Two cars that increase in value with each passing year are the red 1927 Stutz (above) and the yellow 1929 Ford Cabriolet (right), both a part of Harrah's Automobile Collection in Reno and Lake Tahoe, Nev. In the pictures above, restoration work is being done at the shops of Wilkinson & Sharp, antique and classic automobile restorers in Festerville, Pa.





Resurrection of a car that has not been too neglected can be done at reasonable expense. This 1939 Mercury has rebuilt brakes and transmission and has been repainted the original black.

Most transmission failures can be prevented with regular fluid changes. On transmissions without a drain plug for the torque converter, change it even more often. If you do, you can reasonably expect up to 100,000 miles of reliable service.

- Lube your car at least at factory-recommended intervals, and it never hurts to lube slightly more often.
- Anticipate the inevitable. If you live in snowy country where road salt causes body cancer, by all means have your car Zeibarted or otherwise rustproofed. It pays in the long run.
- Change such high-mortality items as fan belts, radiator hoses and heater hoses before they fail. You know that eventually they *will* fail. If you replace them all at 75,000 miles, you'll probably never have to worry about them again.
- Check front-end alignment every 20,000 miles, at which time you should also check shocks, repack front-wheel bearings, and check the condition of brake linings, wheel cylinders, drums, discs and the like.
- Whenever you buy a car, whether new or used, it's always a good idea to take a set of socket wrenches and go all over and under it, tightening every nut and bolt you can reach. Then tighten them again once a year, usually in the

1. Tender loving care

The secret of good car maintenance is to overmaintain. Very few people do it—few even keep a car up to the minimum standards spelled out in the owner's manual.

Fewer still look at their cars as long-term investments. At the end of the first three years of ownership, little things start to go wrong. Perhaps when "trade-in" time comes, even some major repairs are threatening. Most owners take this as a sign of imminent disaster. "My car's falling apart," they say, and off they go on the round of dealer showrooms. Here's where the used-car buyer can pick up a good deal.

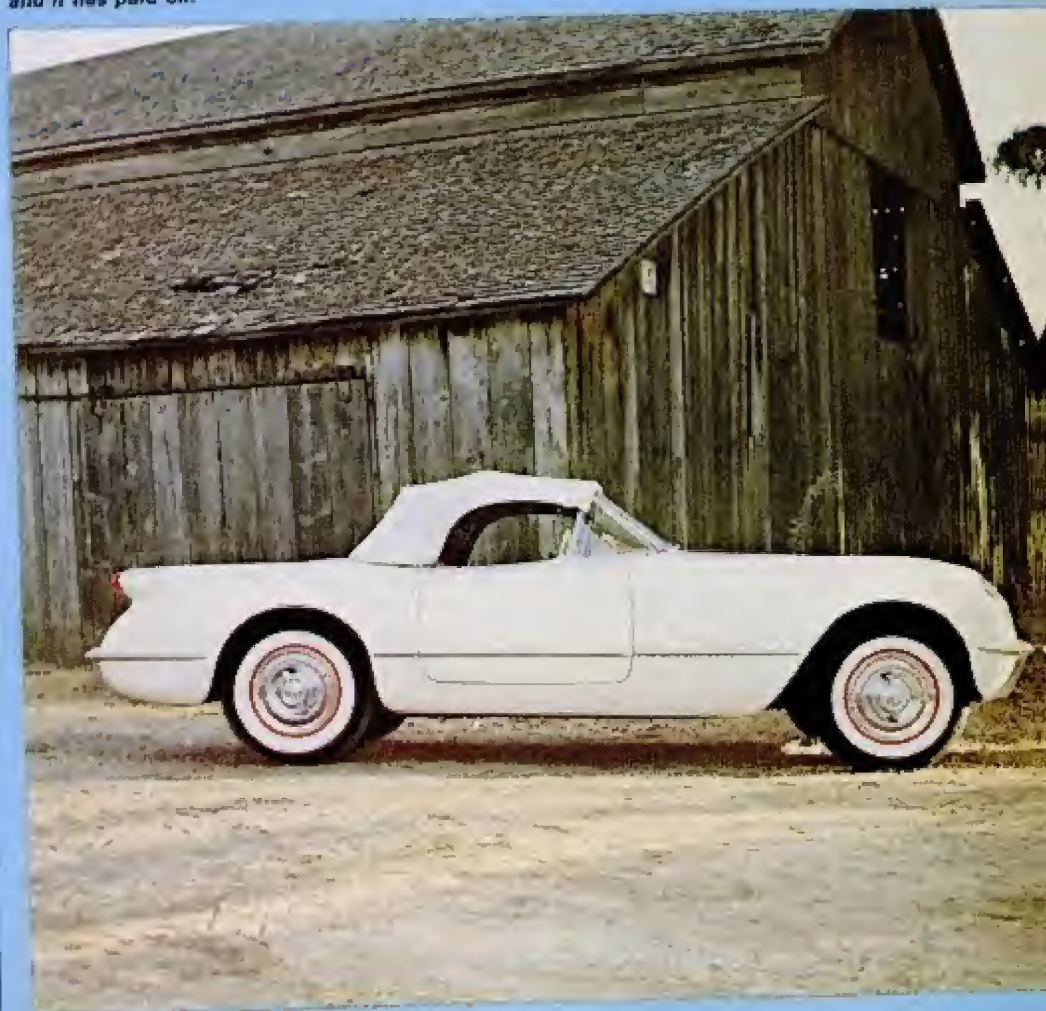
Whether you buy a car new or used, view it as a long-term investment rather than a short-term one, and you'll be ahead lots of money—the more the longer you keep your car. The average car has a 10-year, 120,000-mile lifespan at least. With heavy doses of overmaintenance and tender, loving care those figures can double.

Here's what you do.

- Change oil and filter at least twice as often as specified in the owner's manual. Now that many automakers are recommending oil changes every three months or 6000 miles, owners are opting for the 6000, which often means six months between changes. That's much too long. Too much dirt and acid can accumulate inside an engine in six months. Too much raw gasoline can dilute the oil, and no filter, no matter how effective, can remove it all. When you compare the cost of an oil change with the cost of engine work, you realize how inexpensive oil really is.

- Likewise, change your automatic transmission fluid every 20,000 miles.

Tender loving care can keep a car like new for many years and minimize the necessity for major work. This white 1954 Corvette got lots of TLC and it has paid off.



CAR CARE GUIDE HOW CAR CARE PAYS OFF

spring. You'll be amazed at how many squeaks and rattles you'll prevent that way.

■ Change all filters regularly, especially those elements you can see—air cleaner and gas-line filters. When these become dirty, ditch them. Filters are cheap; ring jobs aren't.

gaskets are all in these kits. Often, with a \$5 zip kit plus another \$5 for new points and condenser, you can forestall a major tune-up that might cost three or four times that.

So much for basic overmaintenance. You'll find that overmaintenance really does work.



Tender loving care on his 1959 Rambler has put owner, P.W. Lowe, way ahead of the game!

■ Proper care of paint includes a good wax job early every spring and late each fall. Be sure you get off all the dead paint. Pay special attention to chrome, but never use steel wool or abrasive cleansers on it. If you have rust on a chromed part, you'll have to remove the spot carefully, not scratching the chrome around it, and then use, say, an aluminum paint to touch up the exposed metal.

■ Salt cancer being the problem it is, try to avoid heavily salted roads. Often, of course, you can't; in those cases, wash your car as often as you can. Squirt undersides with warm water.

■ Sparkplugs need replacing less often than maintenance manuals would have you believe. Plugs should be sandblasted and gapped every 20,000 miles or so. Few filling stations own sandblasters any more, but if you can find one the blasting charge is usually about 15 cents a plug—surely a lot cheaper than replacements. You can ordinarily get 60,000 miles from a set of plugs.

■ When acceleration becomes sluggish or the car gets hard to start, a carburetor zip kit (rebuild kit) might work wonders. If you've never zipped a carb, give yourself plenty of time for the job—a whole weekend for the first one. Instructions, gauges for setting float levels, plus replacement parts and new

2. Resurrection

"Trade for a new car every two or three years." It's an unwritten law—a great American tradition.

Yet it makes no economic sense. It's usually cheaper to fix than to switch. Depreciation takes its greatest toll during the first two to three years of ownership. A person barely gets his car paid for, and boom! he trades it for a new one. Same thing all over again: payments and depreciation.

If this person would hang onto his car, his repair bills would go up, yet he could sink an awful lot of cash into repairs before he'd equal the price of a new car today.

More and more Americans are beginning to question the wisdom of the trade-in tradition. People are hanging onto their cars. They're fixing rather than switching, trying to find ways to beat the spiraling costs of new-car ownership. If you're among them, you might be asking yourself these questions:

Is keeping and fixing the right thing to do?

How many years or miles is a car supposed to be good for anyway?

Will I be pouring more money into the old family bus than it'll ever be worth?

Where can I get minor and major

work done at reasonable prices? How do I pick a good mechanic and a good shop?

Let's examine those questions one at a time.

Is my car really fixable?

To answer that, consider these statistics—some were mentioned in the TLC section. The American Automobile Assn. and the U.S. Department of Transportation estimate the average lifespan of an American car at 10 years or approximately 120,000 miles. A well cared-for car can often double both those figures. Taxi companies usually rack up 250,000 to 300,000 miles on a cab before putting it out to pasture (granted, cabs do use heavy-duty parts, but look at the beating they take).

To give you an idea of what's possible, a Maryland trucker, John Scott, still drives the 1947 International KB-8 that he bought new. This truck's odometer now registers over 2.5 million miles! That's really truckin'. Cars aren't trucks, of course, but never underestimate the service your vehicle can deliver if you treat it right.

You first consideration, then, when asking whether your car is resurrectable, is mileage. How many miles are reasonably left in it? How far short are you of 100,000 to 120,000 miles?

The next question: What shape is the body in? If it's all rusted out, with fenders flapping and the road showing through the toeboards, you're too late. Not only is the body shot, but chances are the frame is badly rusted, too, along with suspension members and some drive-train components.

Say, though, that you've got a car with 60,000 to 80,000 miles on the clock and no major body cancer. Hang on? Repair? Rebuild? Definitely. And remember—this isn't a full-bore restoration we're talking about now. It's more in the vein of reconditioning—giving you car a new lease on life.

How much money to sink into a car?

The question is bound to come up: Am I putting more money into my older car than it's really worth?

If you're talking about your car's value on a used-car lot, you might well end up putting more money into it than it's worth. But that's all right, because you have to consider what the car is worth to you. If you trade for a new car, you'll be laying out \$3000 to \$4000 or more. If you hang onto your present car, you might be sinking \$500 into what's basically a \$300 car, true, but on a cost-per-mile basis, you'll still be cash ahead.

It's your car's antireplacement value that makes it valuable to you, not the rather arbitrary price a used-car dealer puts on it. You're fixing your car to use, not to sell.

Let's take an example. Suppose you own a 1967 Belvedere with 75,000 miles. The body is basically sound; the car



Volkswagen was right. Ugly is only skin deep

For years, Volkswagen has run great ads telling how the real beauty of their product lies on the inside.

We couldn't agree more.

Which is why we designed our sexy Bradley body to fit perfectly onto a VW chassis.

That way, you wind up with a car that looks for all the world like a \$10,000 GT. But inside, you still get the famous economy and durability of a VW.

And because our fiberglass body is lighter, the finished product

performs better than a stock VW. With top speed increased to 100 mph, and mileage to 35 mpg.

Now, you won't get all this without doing some work. It'll take five or six weekends. But we provide every single part you need and you can do the job with ordinary tools. And you'll find the result well worth your time.

It's the perfect marriage.

The inner beauty of a Volkswagen.

And the outer beauty of a Bradley.

BRADLEY GT

BRADLEY / Automotive Div. of Thor Corp.
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Edina, Minn. 55435

Dept. PM-8

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☐ Send an assembly manual for \$7.00.

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City _____

State _____ Zip _____

Business Phone (____) _____

Home Phone (____) _____

Excellent financing available.

THIS YEAR CAR CARE IS MORE IMPORTANT THAN EVER!

by Michael N. Orren, President
Automotive Parts and Accessories Association

For the 3rd big year, the Automotive Parts and Accessories Association, representing some 5,000 retail outlets, is combining forces with **POPULAR MECHANICS** and it's nearly 6 million readers to make your driving a safer, more economical, more enjoyable experience.

This year's program is the best yet, with more retail outlets and manufacturers and far more diverse products.

And, the President of the United States has called on all of us to be even more

aware of the importance of Car Care. Let's get behind this program and *make* it work—for the benefit of all.

A directory of retailers with specific plans for Car Care Month '75 begins on Page 144. Don't forget to watch your hometown newspapers for advertising from other participants. Many newspapers are also planning special "May is Car Care Month" sections in cooperation with APAA and **POPULAR MECHANICS**. These sections will offer further tips to help you get the most from your car.

Considering the ever-climbing cost of gasoline, the possibility of future gas rationing, and the growing concern over the automobile's impact upon the environment, it is now more important than ever for the car owner to maintain maximum mechanical efficiency through regular car care.

As "Official **POPULAR MECHANICS**/APAA Car Care Month Headquarters," your favorite outlet will be featuring many of the following products as well as offering other items and services to help you do just that.



Ignition system



Car material preservative



License protector frame



Custom bumper guards
Chrome grille crowns



Transmission sealer/conditioner
Engine cleaner
Carburetor cleaner
Tire sealant



Fiberglass repair kits

BURNWORTH TESTER CO.

Circuit tester



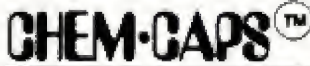
Brake assembly solvent



Auto ramps



Spark plugs



Battery terminal protectors



Ventilated Seat Cushion

DEFLECTA-SHIELD
Deflectors



Timing light
Engine analyzer
Ignition tester
Dwell-Tach timing light

DUPLI-COLOR Products

Spray paint



Car wax

AUTOMOTIVE SILICONES

Carb cleaner/lubricant
Windshield/glass seal
Battery care
Hi-Temp instant gasket
Silicone penetrant

GENERAL ELECTRIC
Headlights



GIANT TIRES
Tires



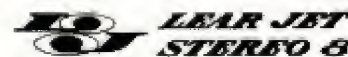
Hand cleaner



Oil additives



Motor oil
Racing oil



B-track stereo tape players



Air filters
Oil filters

Mark Fore VATCO

Car ramp



Ignition analyzer
Timing light
Analyzer timing light
Tune and test kit
Master test and tune kit



Rislone engine treatment



Touch-up paint



Fiberglass repair kits
Autobody patch kits
6-piece car body patch kits



Spray lubricant



Wheel wrenches



Universal lubricant

Westley's

Whitewall tire cleaner/conditioner
Silicone polish concentrate



Fastener locking liquid
Sealant for non-porous material

CAR CARE GUIDE HOW CAR CARE PAYS OFF

runs fine but needs front-end work, new tires, and the automatic transmission is starting to hang up in low range. On the open market, this car might be worth \$400. But it's worth a lot more than \$400 to you, because it might cost 10 times that to replace it with a new car. Tires and front-end work, you find, will cost \$250, and you might soon have to lay out \$350 to overhaul the transmission. Should you keep the car? If it's basically reliable and respectable-looking, yes—you should. Your cost per mile will be far below what you'd be paying to go the same distance in a new car or even a late-model used one.

Where to start?

Suppose you've decided your car is worth resurrecting. Where do you begin? In what order do you proceed?

Answer: Work on safety-related systems first, then on items that affect reliability, and finally on comfort and cosmetics.

Safety-related components include brakes, tires, suspension, steering, muffler, lights, windshield and wipers. People tend to neglect them, mostly because they wear gradually, and they give little warning before they fail. But when resurrecting your car, you have to start here despite the fact that safety items usually don't show. And because they don't (a brake reline can't compete with a new paint job), too many people overlook establishing a solid safety base in a car before going on.

One note here: When you buy new tires for an older car, don't buy more mileage than you'll need. Get a good grade, but if you expect to drive your car only another 25,000 miles, there's no point in putting on steel-belted radials with a 40,000-mile warranty. Be reasonable.

The second system to tackle has to do with reliability. Turn your attention to everything that makes the car move: engine, transmission and running gear. Don't overlook radiator condition. Remember that electrical-system failures—battery, wiring, starter, alternator, voltage regulator, and switches—rank as the No. 1 causes of on-the-road breakdowns.

After you've gotten all the important safety and reliability work out of the way, you can concentrate on your car's looks: body work, paint, and perhaps chrome and upholstery. If you have time, you can do some cosmetic work yourself: polishing and waxing, perhaps sanding in preparation for painting, replacing a dented grille or even a fender. Remember that every hour you can keep your car out of a mechanic's hands means money earned and saved.

How do you find a good mechanic?

You won't be able to do all the resurrecting yourself. You'll need good professional help, but finding a good repair shop is becoming tougher every

day. All shops are crowded and getting more so. No one's hurting for business—not even the more marginal operations.

Before you start your search, it's important to know something about the shops and their prices.

There are five different types of auto-repair shops: 1) dealer service departments; 2) independent garages; 3) specialty shops like front-end, transmission and body shops; 4) franchisers like Sears, Firestone, Midas,



Faithful maintenance and repairs when necessary have kept this 1947 International KB-8 truck on the road for 28 years and over 2½ million miles!

Grand Auto, and 5) filling stations.

Dealer service departments are probably the most expensive. Their usual charge for labor runs \$15 to \$20 an hour, depending on size and locale. Auto repairs seem to be more expensive on the West Coast than in the East; in the San Francisco/Oakland area, some dealers now charge \$28 to \$32 an hour! Parts, of course, are an extra charge.

Most dealer mechanics work by what's called "the flat-rate manual." It lists how long it's supposed to take an average mechanic to do a specific job—everything from changing a wiper blade to overhauling an engine. There are two major commercial manuals: *Motor's* and *Chilton's*. These list repair times for every car built within the past eight years. The shop then multiplies the flat-rate time by its own hourly rate, adds the cost of parts, and that's what you pay.

Most independent garages also work by flat-rate manuals, but charge less than dealer shops. The independents usually get \$3 to \$5 less an hour than dealers. Sometimes, independents don't work by flat-rate time but by straight time or by the specific job. Some consumer groups feel flat-rate charges are unfair, because mechanics do their darndest to beat flat-rate times. A good mechanic can beat the manual consistently, which means you're paying the flat-rate shop more per hour than it warrants. Of course, if you hit a slow mechanic, or if the mechanic gets

stuck with a particularly hard-to-work-on car (one that's badly rusted, say), you come out ahead of the flat-rate game.

Specialty shops doing brake work, transmission work, body work, can usually do it faster and less expensively than either dealer shops or independent garages. And they generally charge by the job, not by the hour.

The other types of repair and service facilities—franchisers and filling stations—ordinarily tackle only the quick-in/quick-out jobs: replacing shocks, installing new tires, minor tune-ups and so forth. Their rates are sometimes competitive, sometimes not. Filling station repairs probably vary the most in quality and price: It's hardest to find a good one.

Getting down to choosing specific shops, remember that no single one can do everything—at least not economically. Some dealers and most independent garages generally subcontract work like radiator repairs, valve grinding, body work and glazing. In those cases, you'll be better off by taking your car direct to the specialists.

Then, too, dealers will often replace an item with a part from stock rather than rebuilding or repairing it (and yes, often it is cheaper to replace than to repair). Rather than re-ringing a worn engine, for example, many dealers will install a new short block. An independent will more likely take the overhaul route. Which route gives the better, cheaper result depends on who's doing it.

A good shop will have three basic things going for it: reputation, modern equipment and neatness. Of the three, neatness counts least—some very good shops also happen to look pretty messy.

To find out about a shop's reputation, ask around: friends, neighbors, people you work with. Chances are you'll hear some bad things about certain shops, but that's fine—it'll help in the process of elimination. Don't hesitate to buttonhole customers inside a prospective shop. Ask them how long they've been customers and what they think of the service.

It's a lot easier to judge a shop's equipment and neatness than its reputation. Modern diagnostic equipment is particularly important nowadays, especially with the critical states of tune demanded by emission controls.

The most economical way to care for your car, of course, is to do as much repair and maintenance work as possible yourself. By removing and reinstalling the heads at home, for instance, you can save \$150 to \$200 on a V8 valve job. You simply deliver the heads to a reconditioning shop and pick them up the next day.

There's no reason why, with a little extra care and attention, your car can't outlast the statistics by many years and

CAR CARE GUIDE HOW CAR CARE PAYS OFF

miles. A car can only be as good as the attention you give it.

3. Restoration

The meaning of "restoration" depends largely on who's saying it. To the owner of an Antique Auto Club of America (AACA) Grand National prize-winning Duesenberg or Pierce-Arrow, it means 100 points on a concours judging sheet: a restoration so authentic, so flawless, so dustfree that the show judges see the car as brand new—or better.

To the fellow selling his faithful old work car, the word takes on an entirely different meaning. When you read, "For Sale—1950 Chevy, fully restored, \$650," chances are this man's not talking the same language as the AACA judge.

Restoring old cars has become big business, just as old cars themselves have become big business. There are now some 150 professional restoration shops nationwide that do nothing but restore antique, classic and special-interest cars. They cater mostly to hobbyists, but also to investors and speculators in old cars, some of whom make good money buying, restoring and selling.

Restoration definitely isn't for everyone. The average motorist rarely ever sees the inside of a professional restoration facility. We're not advocating that you take your venerable Valiant or that faithful Fairlane to a professional restoration shop. You'll probably get laughed out if you do. You'll be told how much it costs to restore a car—a minimum of \$5000 to \$7000, sometimes up to \$60,000—and then you'll chuckle a bit, too.

So while a full restoration on what we'd consider a common used car is out of the question, there's still a lot the average car owner can learn from the professional restorer. The restoration business is worth knowing about. You might even own a car that's worth either restoring yourself or having a pro help with a partial restoration.

Ironically, despite the high tabs, professional restorers generally charge less on an hourly basis than dealer mechanics and independent garages. They currently charge between \$11 and \$14 an hour for labor. Parts are additional. Compare this with our earlier rate estimate in dealer shops of \$15 to \$20 an hour and in independent garages of \$12 to \$15.

That's not to say every professional restorer bills \$11 to \$14 per hour. Some charge less and others—not necessarily the best—charge up to \$20 an hour. The point is you don't always get what you pay for when it comes to high-priced repairs or restorations.

Remember, too, that what a shop charges per hour often doesn't mean too much, because you might end up

paying more to a slow shop with a low hourly rate than to one that works briskly at a high fee. A good shop, though, will always have a waiting list—from 3 to 18 months long. To get on this list, you'll have to put down a deposit—usually \$500 to \$1200 in advance. Then several weeks before your turn, the shop will call you and make an appointment. When your car is in restoration, you'll be billed once a month on parts and labor.

While restorers generally charge less per hour, they put a lot more hours on a given car than would a regular mechanic. A normal restoration might take a year or 18 months; one restoration we know of took *four years!* Independent garages or dealer shops couldn't operate under those schedules. Their idea, even at \$25 an hour, is to turn out as many repairs as possible in quick succession. And how would you like it if your family station wagon were laid up for 18 months?

Even then, most pro restoration shops aren't interested in the family wheels. The cars they want have to be worth restoring because if the owner stops payment or can't continue the restoration, the shop doesn't want to

and if it's an A with a rare body style (roadster, phaeton, station wagon), you'll have a car worth about \$10,000. Now that's a "street" restoration, not a high points job that'll win concours.

Perhaps, though, you're considering having a special-interest car restored. Here you have to exercise extra caution, because some special-interest cars simply aren't worth restoring: Kaisers, most Studebakers, Hudsons, the commoner Chryslers, Chevys, Plymouths, Pontiacs and so forth. That's not to say that *none* of them are worth restoring—just that most aren't. An early Plymouth phaeton definitely is, but a 1937 Plymouth sedan definitely isn't.

Remember, too, that you can always settle for a partial restoration. You don't have to go all the way, and you don't have to let a pro do the whole thing—you can take on parts of it yourself. Some shops specialize in partials. One in New England purposely brings a car up to what might be called "respectable" condition. The owner then finishes the job. Says the owner of this establishment, "I think our customers are looking primarily for cars they can finish themselves. We assemble the car, make it 90 to 95



Restoration of classic like this Model T Speedster is labor of love—and an investment!

get stuck with a relatively worthless used car.

Suppose, though, that you do own a car worth restoring. If it's a Duesenberg, no problem. It now costs roughly \$60,000 to restore a Duesie, so the restoration represents a sound investment, because you'll end up with a car worth \$100,000 to \$200,000. It's money in the bank—or at least has been in the past.

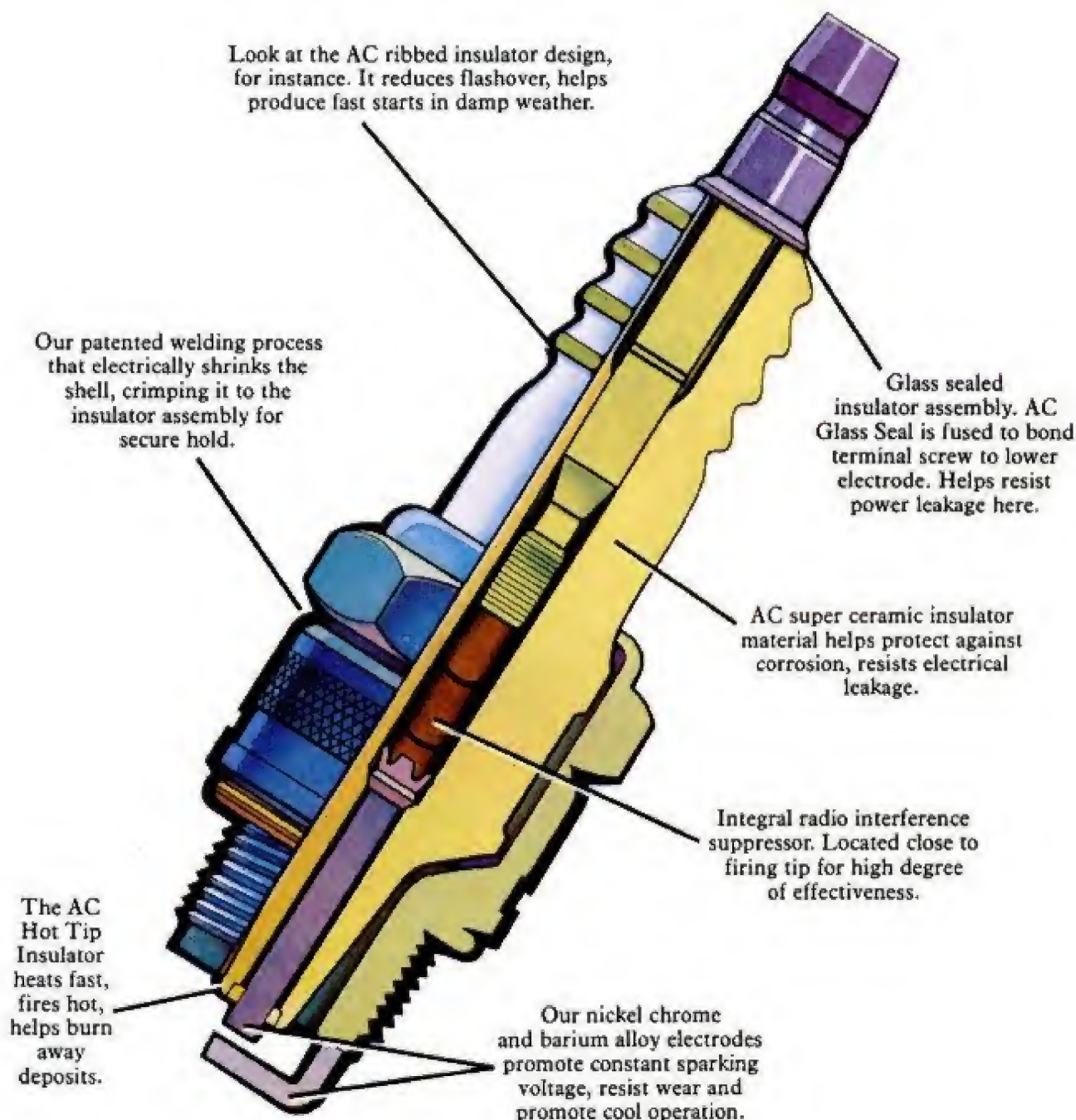
The same sort of math holds for most other classics, many antiques and a growing number of special-interest cars. A normal "street" restoration of a Model A Ford will run around \$6000,

percent complete, then hand it back to the customer. A restored car ends up costing about half what it would if we did the thing completely. And many people want to restore their own cars."

Then, of course, you can become your own subcontractor. Do as much of the restoration work as you can yourself and contract for the rest of it.

There are restoration outfits that cater specifically to car owners who like to do part or much of their own work. Some specialize in mechanical repairs, some in upholstery, others in painting, still others in final detailing. Just pick the service you need. ★★★

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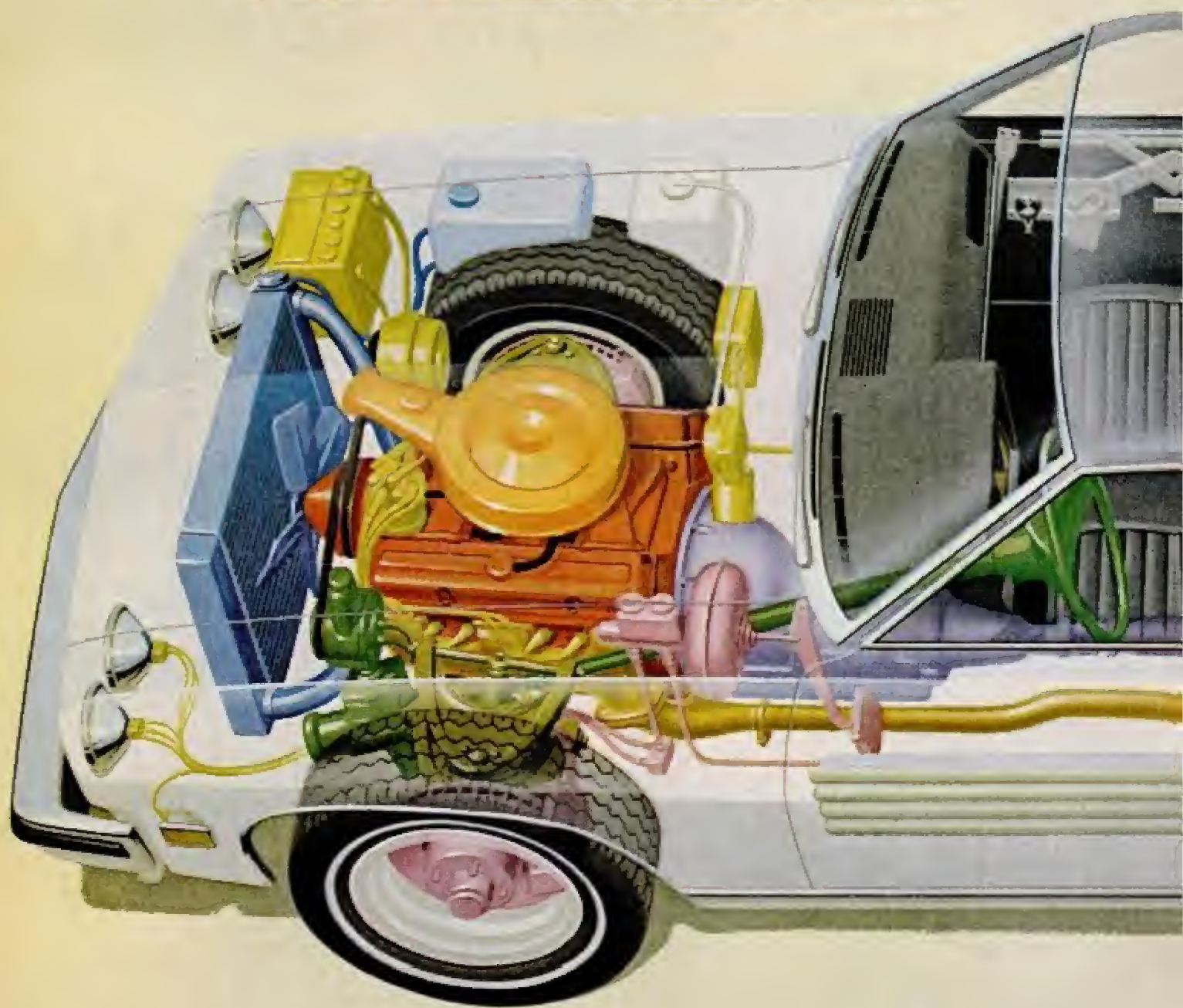


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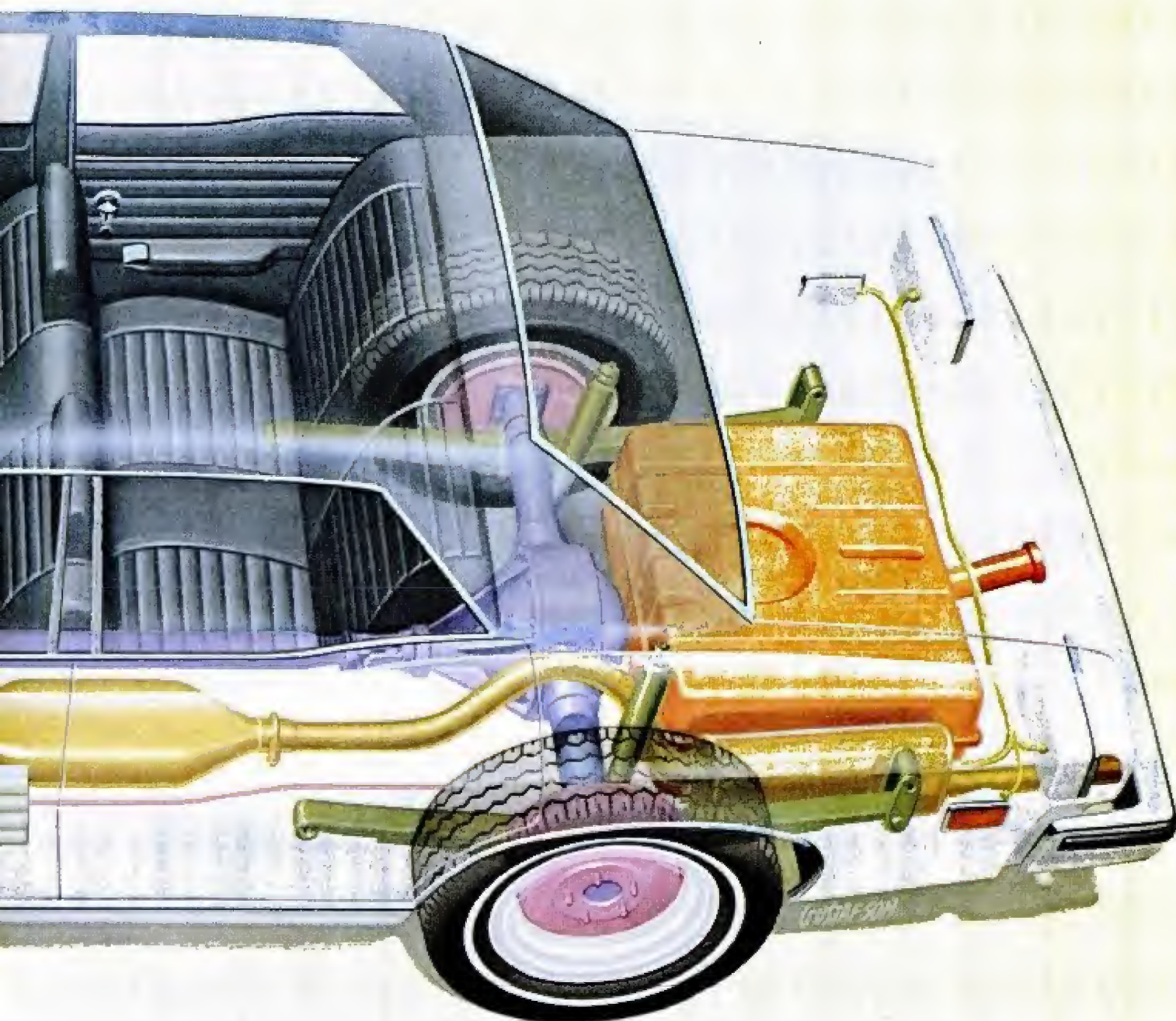
PM'S CLEAN MACHINE



● V8 engine ● Drive train ● Fuel system ● Braking system ● Electrical and ignition systems

The cared-for car is clean inside and out — from the fresh wax on the surface to the clean oil on the crankshaft. You can only keep it that way by getting out and getting under. Of course you have to know what you're looking at, and what you're looking for.

When you know how your car's many parts and systems work, the fixing comes easy. The sections that follow will show these systems in detail and the how-to steps for keeping a clean machine.



● Cooling system ● Steering system ● Suspension system ○ Exhaust system

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Inside Just pour a pint of GUMOUT into your gas tank. It cleans out all the jets and passages, removes gum and varnish while you drive.

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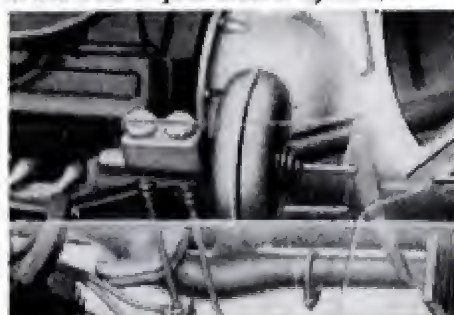
GUMOUT Cleveland, Ohio 44104

HOW TO USE PM'S CAR CARE GUIDE

We're going to make car care easy for you — even if you've never lifted a hood before. Okay, you may have to refer to your car's owners manual — for the location of that hood release, for example! But once you've found it you'll be able to find it again even if you're blindfolded. And you'll also know the second time around whether you have to push it, pull it or twist it to make it work.

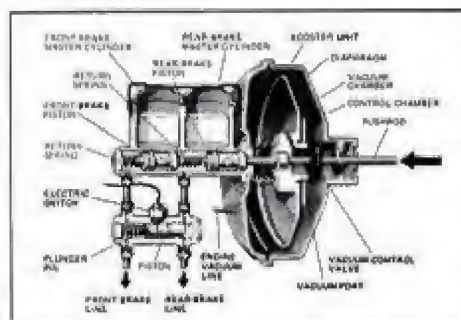
It's the same with any job on your car: the first time is the hardest, but from there on in, it's time and money saved.

1 Take your car's braking system for example. It's shown in pink on PM's Clean Machine on the previous pages. Something you want to keep an eye on is the level of brake fluid in your master cylinder —



which is shown here and is easily located in the engine compartment.

2 Then, when you turn to Section 6, Braking System, page 173, you'll see the master cylinder in a cutaway drawing to show you how it works. That cutaway is shown here just as it appears on page 173. And when



you know how it works, it's easy to maintain, service and repair.

3 Finally, for the real how-to information on maintenance and care, all you do is turn the artwork page that begins Section 6 to the how-to pages that are illustrated with photographs. There (page 174) you'll see the actual master cylinder pictured, as you see it here with its cover lifted off.



You use the other sections in the same way. The art and photos in PM's Car Care Guide take you from the general to the specific for all of your car's systems. Just locate that hood release and take it from there!

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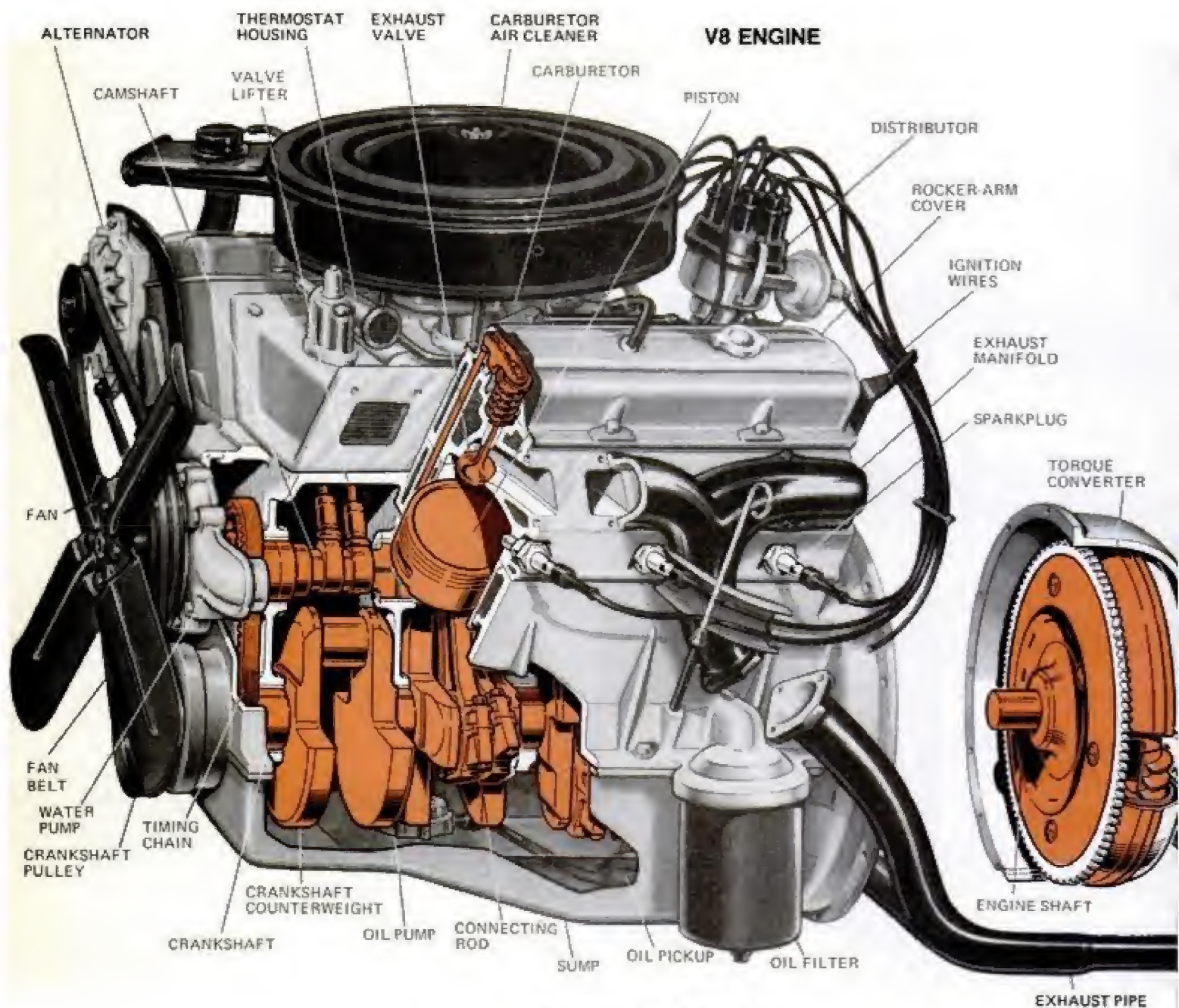


'round the house

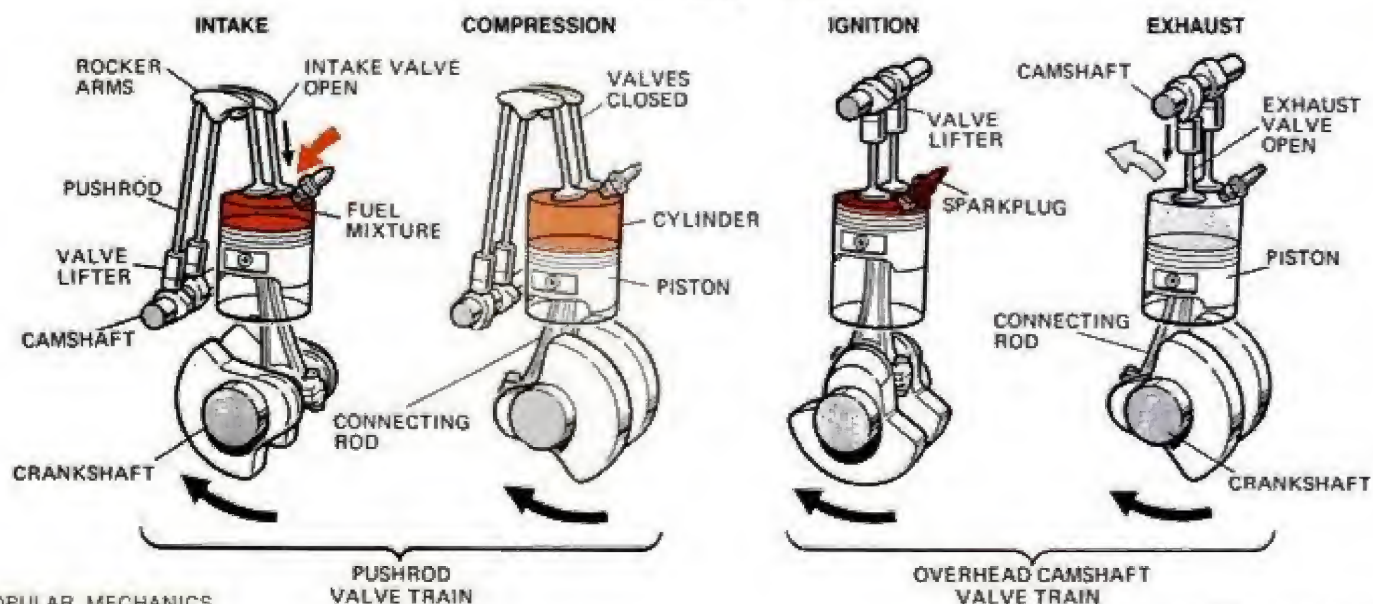
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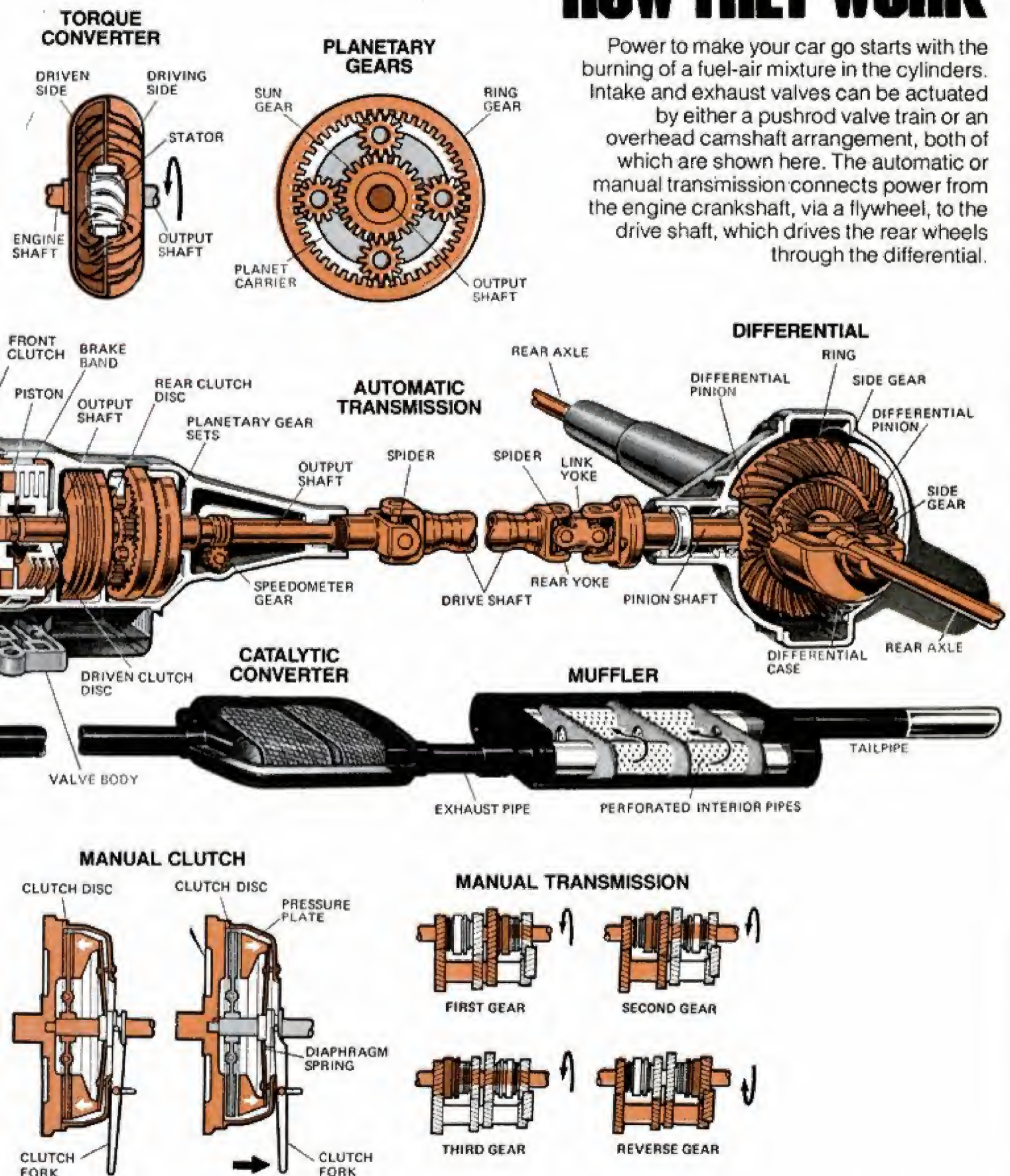


FOUR-STROKE CYCLE



1. ENGINE AND DRIVE TRAIN: HOW THEY WORK

Power to make your car go starts with the burning of a fuel-air mixture in the cylinders. Intake and exhaust valves can be actuated by either a pushrod valve train or an overhead camshaft arrangement, both of which are shown here. The automatic or manual transmission connects power from the engine crankshaft, via a flywheel, to the drive shaft, which drives the rear wheels through the differential.



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1. ENGINE AND DRIVE TRAIN: HOW TO KEEP THEM WORKING

Two tests—compression and vacuum—tell whether an engine is performing at peak condition. To do a compression test:

1. Warm the engine up to normal operating temperature and then shut it off.

2. Blow dirt from around sparkplugs with an ear syringe or by blowing through a soda straw. Remove sparkplugs, making sure you mark or remember which plug goes with which cylinder. This is important later.

3. Examine each sparkplug. Look for signs of trouble as follows:

- **Oil fouling**—wet, sludgy deposits indicate that oil is entering the cylinder through worn piston rings, valve guides or bearings.

- **Burns and/or blisters**—a ghostly white or blistered insulator nose and eroded electrodes indicate ignition timing is way out of specification, there's an obstruction in the cooling setup, or preignition is taking place. Preignition—a very serious problem—means that ignition is occurring before the sparkplug fires. Hot carbon in the cylinder is normally the cause.



Keep throttle plate open for compression test.

- **Carbon fouling**—dry, black deposits indicate your engine's been operating on an overly rich fuel mixture, you've been idling for excessive periods, sparkplugs aren't the right ones, or there's a breakdown in ignition. If sparkplugs show little electrode wear and have tan or brownish deposits, they're okay to this point. If plugs aren't badly worn, they can be cleaned, regapped and returned to the cylinders from which they were taken



Compression tester is held in sparkplug hole while engine is cranked.

after you complete the compression test.

4. Remove the carburetor air cleaner and set the throttle plate(s) in the wide-open position by wedging open the throttle shaft and lever assembly. You can use a block of wood or simply tie the cam open with a length of string or wire.

Make sure the choke plate is also wide open. With the engine warm, automatically controlled choke plates should be fully open. If not, there's a hangup in the choke assembly.

5. Push a compression gauge firmly into a cylinder. It has to be tight so no compression is lost. Use a remote starter to crank the engine, or ask someone to give you a hand. A remote starter allows you to crank the engine from beneath the hood. Its terminals attach to the solenoid terminal (marked S) on the starter solenoid and to the battery's positive post. The engine is then cranked by pressing the button on the tool.

6. Crank the engine through a minimum of four complete compression strokes to get the highest reading. Repeat the test for every cylinder, recording each reading.

You need the compression specification for your engine, which can be gotten from a dealer or by consulting a general automobile repair book, such as *Motor's Auto Repair Manual*, for foreign or domestic cars, available in most public libraries. Some owner's manuals provide the specifications, as do car service manuals.

Conclusions you can reach from this test are as follows:

- If all cylinders test within manufacturer's compression specification limits, overall engine condition is sound.

- If compression in any cylinder fails to climb during all cranking strokes, or remains the same on the first two strokes and then climbs higher on the following strokes, a sticking valve exists.

- If compression reads below manufacturer's compression specification limits, worn rings or a bad valve (burned, not seating) exists. To test for worn rings, pour a tablespoon of heavy motor oil into the cylinder, crank the engine to distribute oil and test compression again. If the reading shows a sharp rise, rings are worn, but if the reading remains the same, the valves are in trouble.

- If there is a compression loss below manufacturer's limits between adjacent cylinders, there's a good chance that the head gasket is bad, resulting in a compression leak occurring between cylinders.



Connect vacuum gauge to vacuum port.

- If compression reads more than 10 pounds above manufacturer's limits, carbon is building up in the cylinders. This results in very sluggish starting of warm engines, even though they start fine when cold.

What a vacuum test can tell you

In some cases, an engine vacuum test can reveal some of the same malfunctions that a compression tester will turn up. However, the two instruments test different functions, and each of them can give you



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longest lasting you can buy.

Install the STP Filtration System. Because if you know a thing or two about cars, you know what you put into them is what you get out of them.



CAR CARE GUIDE 1. ENGINE AND DRIVE TRAIN

valuable and different information.

A vacuum reading of 17 to 21 inches of mercury at sea level that holds steady is generally regarded as a normal reading. However, this is not true for every engine, and you should seek the manufacturer's specified reading for your engine.

Keep in mind, too, that altitude affects vacuum, and that vacuum gauges are calibrated for sea level. For every 1000 feet above sea level, subtract one inch of vacuum from the readings you get.

To take a vacuum reading, reinstall sparkplugs if you have just done a compression test, and warm the engine up again if it has cooled below normal operating temperature.

Connect the vacuum gauge. Every engine has at least one vacuum port.

Start the engine, let it idle and observe the reading (making compensation for altitude, if necessary). One of the following is the result you'll get:

VACUUM TEST RESULTS

Vacuum reading	Meaning
Gauge needle floats over range of 4 to 5 inches.	Carburetor out of adjustment.
Needle holds steady, but below spec.	Ignition timing out of adjustment.
Needle drops intermittently about 4 inches.	Valves are sticking.
Needle drops and rises alternately.	Burned valve or insufficient valve clearance—a leaky valve, that is.
Reading normal at idle; vibrates when engine is revved.	Weak valve springs.
Needle vibrates at idle, but holds steady when engine speed is increased.	Worn valve springs.
Needle vibrates at all speeds.	Leaking head gasket.
Needle drops slowly to zero as engine speed is increased.	Restriction in exhaust system.
Steady reading that is low.	Valve timing is off.
Needle holds steady, but is low.	Leaky intake manifold or carburetor gasket.

Notice that a leaking intake manifold or carburetor gasket and incorrect valve timing results in the same kind of reading. Most times, the cause is a bad gasket, but this can be easily verified.

Apply a good deal of heavy motor

oil around intake manifold and carburetor joints. If a leak exists, the vacuum gauge needle will rise as the engine idles.

Even if you get a normal reading to show that engine vacuum is adequate, there might still be a loss of vacuum from a leaking hose. Hoses connect vacuum-operated components, such as the distributor vacuum advance and headlamp covers, to the source or vacuum—the engine.

Disconnect the vacuum gauge and allow the engine to idle. Trace each vacuum hose from its connection on the engine to its vacuum-operated component. Listen carefully. If a hissing sound comes from the hose, replace it.

How to examine the exhaust system

Examining the exhaust system, which should be done routinely every year or as soon as you suspect an exhaust system leak because of, say, roaring, may be a matter of life and death. Lethal carbon monoxide fumes escaping from a bad component can leak into the passenger compartment.

The examination should be meticulous. Here's how to do it:



Exhaust manifold and exhaust pipe flange should be checked for leaks.

1. Examine the connection formed by the exhaust manifold and exhaust pipe flange. This can be done from beneath the hood. If there are whitish deposits around the joint, the gasket has probably gone bad and exhaust is escaping. Replace the gasket and make sure that bolts are tight.

2. Lift the car and carefully examine the exhaust pipe, exhaust extension, muffler, tailpipe, and all other pipes and parts, such as resonators, that are used. Run your hand over each part feeling for soft spots where rust has eaten nearly through the metal. Naturally, any part that has a hole or split should be replaced.

3. To check parts for internal failure (many times parts fail from the inside, where acid collects), tap each with a wrench or pair of pliers. If the part is sound, it will ring. If it is failing or has failed, it will give a dull thud.

4. See to it that all parts are



Check muffler for holes and probe for weak spots that'll soon rust through.

secured by tightened clamps and hangers. A part that vibrates against the floor pan, frame, fuel tank or whatever will soon destroy itself.

5. Look beneath the exhaust manifold for the manifold heat-control valve (not all cars have one although most do). The valve should move freely when you manipulate the counterweight. If it doesn't, try to tap it free with a soft-nosed hammer.

Lubricating the manifold heat-control valve is a job to do whenever you lubricate the chassis. Use manifold heat-control-valve lubricant or graphite. If this valve sticks, it causes many different kinds of problems, including rough idle and stalling, poor gas mileage, shortened sparkplug life and burned valves.

Emissions control

The type and number of anti-pollution devices on an engine depend on the car's year and manufacturer so check your service manual for what's on your car. The following information outlines the most widely used emission controls and how to service them:

Positive crankcase ventilation (PCV)

The earliest of the emission controls, PCV was first put on engines in 1963. The system has been in use ever since to prevent hydrocarbon emissions from the crankcase into the atmosphere. It is serviced as follows:

■ Start the engine and locate the PCV valve (consult your owner's manual). Pull the valve from its seat. You should hear it hissing.

■ Cover the end of the valve with your finger. You should feel a strong pull (vacuum). If the valve does not



Check PCV valve periodically.



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CAR CARE GUIDE



PCV hoses should be kept clean.

make a hissing noise and does not provide vacuum pull, turn off the engine, clean out any deposits that have formed in the PCV valve hose and replace the valve with an exact duplicate.

■ Examine the hose from the PCV valve to the exhaust manifold, and the one from the carburetor air cleaner to the cap covering the rocker-arm cover. See that they are straight and free of cracks. Replace a cracked hose with a new PCV hose that is oil-resistant.

■ Remove the carburetor air cleaner cover. You may find a small filter element on the other side of the spot where the PCV hose intercepts the air cleaner. Some filters are mesh and are stuffed into the hole in the side of



This PCV filter is mesh type.

the air cleaner. Others are cotton and are placed in a small plastic holder. Replace this filter every 12,000 miles, or more often if it gets dirty.

Many foreign cars employ a gulp valve rather than a PCV unit to control crankcase emissions. To service this valve, remove the cover, which is probably held by a spring clip. Examine the diaphragm inside, and replace it if it's damaged. Clean the inside of the valve and make sure the small metering hole is not clogged. If necessary, ream it out with a piece of wire, but take care not to enlarge the hole.

Thermostatically controlled air cleaner

Beginning with some 1968 models and extend to present models, carburetors have been outfitted with this device which helps reduce hydrocarbon and carbon monoxide levels by maintaining

L. ENGINE AND DRIVE TRAIN

the air entering the carburetor at a minimum temperature (100°F). This permits carburetors to be calibrated for the leanest possible fuel mixture. Service the air cleaner every 12,000 miles as follows:

■ Remove the filter element and replace it if it's damaged or clogged with dirt.

■ Clean the air cleaner housing. Place the assembly back on the carburetor and tighten the fastener.

Caution: The wingnut or bolt holding the air cleaner in position should not be overly tight. Excess pressure may damage the carburetor.

■ With the engine cold, look into the snorkel. The valve should be closed. Start the engine. As it gets warm, the valve should open. If the air cleaner doesn't function this way,



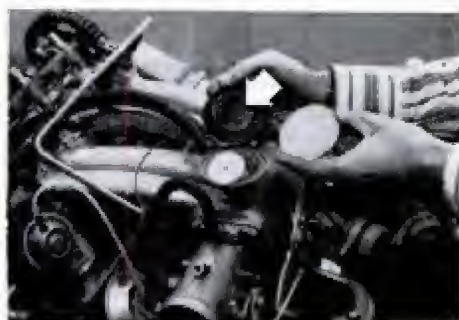
This PCV filter is fiber type in holder.

its diaphragm assembly or sensing thermostat has malfunctioned. Parts can be replaced.

Electric-assisted automatic choke

Beginning with some 1972 models and continuing with 1973-74 models, many cars were equipped with a device that introduces electric current to open choke plates fully as soon as possible. This cuts down on the amount of exhaust emissions given off by cold-starting cars.

If your automatic choke linkage and plate pivot points are clean so the choke won't bind, the choke plate should open within 60 to 90 seconds after starting a cold engine. If it



Gulp valve diaphragm should be checked.

doesn't, there is a problem with the electric choke switch or heating element, both of which should be tested.

Exhaust gas recirculation (ERG) valve

This was added to many models beginning in 1973. The valve sends metered amounts of exhaust gas into the intake manifold to dilute the fuel



Thermostatically controlled air cleaner parts are: 1. temperature sensor and 2. damper valve.

mixture, thereby reducing the combustion chamber temperature at which nitrogen oxide is formed. Service the EGR valve every 12,000 miles as follows:

■ Remove the valve from the engine and hold it in your hand. Don't clamp it into a vise where it can be damaged.

■ Tap the sides and end of the valve lightly with a plastic hammer to loosen deposits that have formed on

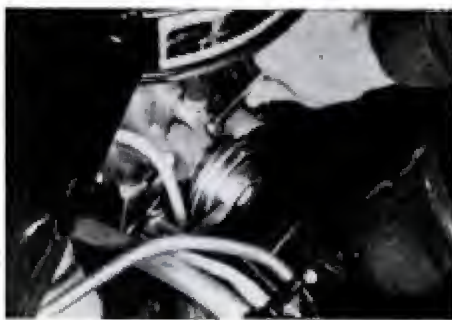


Damper valve is closed on cold engine.

the valve seat. Blow deposits out by mouth.

■ With a wire brush, buff deposits that remain from the mounting surface and from around the valve.

■ Depress the valve diaphragm and



Remove EGR valve for service.

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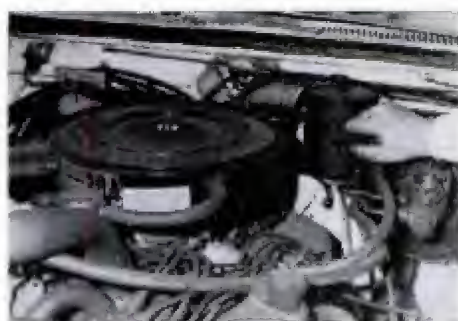
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CAR CARE GUIDE 1. ENGINE AND DRIVE TRAIN



Remove fuel evaporative control canister to service the filter.

examine the valve outlet. If there are deposits, loosen them with a screwdriver, but carefully.

Fuel evaporation emission control system

This system has been in use since 1971. It seals off open vents in the carburetor and fuel tank, directing fuel vapors that build up into a charcoal canister instead. The canister is mounted in the engine compartment of U.S. and most foreign cars, and in the luggage compartment of other imported cars.

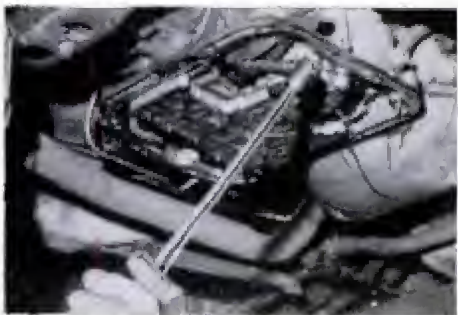
U.S. automobiles and many made overseas have canisters that possess filters in their bases. These filters should be replaced every 12,000 miles.

Other imports don't have filters. In these, the canister itself should be replaced every 50,000 miles.

Think transmission

Given occasional service, the transmission will probably serve you for the life of your car. Without care, it will eventually fail, and you will face a stiff repair bill.

One reason for an automatic transmission malfunction, such as delayed shifting, is fluid level that's getting too low. Fluid may be lost



Adjust automatic transmission bands.

because of a leak, so check the level frequently.

Every owner's manual outlines the procedure for checking transmission fluid, but it's usually as follows:

1. Warm the transmission up to its operating temperature by driving the car about 10 miles.

2. Park the car on a level surface and place the transmission gear

selector lever in Park (P). Turn off the engine if manual so states.

3. Locate the automatic transmission fluid dipstick in the engine compartment. Wipe dirt from the dipstick tube with paper toweling or a lint-free rag. Do a thorough job. Dirt that gets on the dipstick or falls into the dipstick tube will contaminate the fluid.

4. Pull the dipstick from the tube and "read" the level. The level should fall on the "Full" mark or between the "Add" and "Full" marks.

5. Add fluid if the level is low by inserting a clean funnel into the dipstick tube and pouring fluid into the transmission through the funnel. Use the type of automatic transmission fluid specified by the manufacturer.

6. Do not overfill the transmission. Fluid level should not go above the "Full" mark on the dipstick. Excess fluid in the transmission causes aeration—that is, foaming which causes gear slipping and erratic shifting.

Once every 25,000 miles, fluid should be drained and the transmission oil pan removed. Once inside the case, the fluid filter should be replaced and the transmission bands should be adjusted to specification if the manufacturer recommends this.

The transmission pan should be cleaned before it is bolted back in place. Use a new gasket. Finally, the transmission should be filled with fresh transmission fluid.

What about manual transmission?

A manual transmission requires an occasional fluid level check which can be done when you lubricate the chassis. Another important service, which is often overlooked, is adjusting the clutch for free play—that is, for the amount of free movement before the clutch engages.

As a clutch is used, it loses its free play. If this is not restored, clutch parts come into contact with one another when they aren't supposed to, and wear results.

By restoring free play, you may get the clutch to last for the life of the car. The frequency of making adjustments depends on the car, so check your owner's manual. Some manufacturers, for example, recommend an adjustment every 6000 miles, while others suggest one every 12,000 miles. However, more frequent adjustment, or at least checking free play, can't damage anything.

The clutch adjustment is done differently from car to car. Consult your car's service manual, if you have one, or general auto-repair manuals in the library.

Whichever method your manufacturer calls for, the procedure is probably not difficult. In most cases, it's a matter of measuring the free movement by pressing the clutch pedal until

resistance is met. Generally, the clutch needs adjustment if free movement is more or less than $\frac{1}{4}$ inch.

Making the adjustment is usually a matter of loosening a locknut and turning an adjustment screw on the clutch release lever.

Driveshaft and differential

To determine if universal joints are wearing (U-joints hold the propeller shaft to the transmission and differential), grab the propeller shaft with both hands near each U-joint and attempt to move the shaft. There might be slight



Check U-joints for play.

movement, but it should not be excessive.

If the prop shaft demonstrates sloppy motion, it means the U-joint is wearing. The safe thing to do is drop the prop shaft and remove the universal joint for repair or replacement. Universal joint failure can cause you to lose the propeller shaft while driving.

The only service required by the propeller shaft is an occasional cleaning when the car is on a lift. If much mud cakes on the shaft, it can throw angularity out of balance, causing propeller shaft "whip" which could produce the unexplained vibration you may be experiencing.

With a clean cloth dampened with mineral spirits, kerosene or some solvent, wipe the prop shaft down.

The differential (rear end) requires very little care. Just check its fluid level regularly. ★★★

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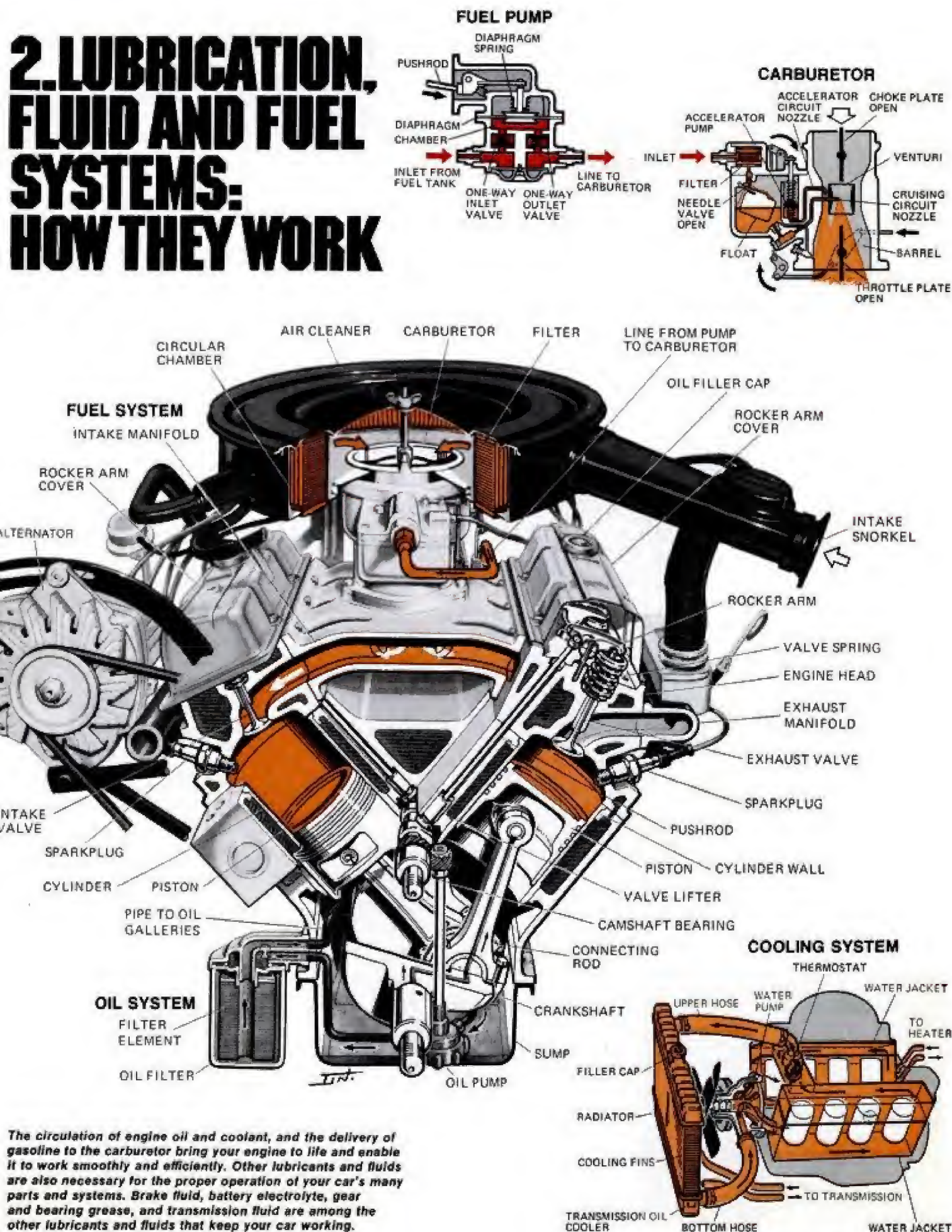
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2. LUBRICATION, FLUID AND FUEL SYSTEMS: HOW THEY WORK



The circulation of engine oil and coolant, and the delivery of gasoline to the carburetor bring your engine to life and enable it to work smoothly and efficiently. Other lubricants and fluids are also necessary for the proper operation of your car's many parts and systems. Brake fluid, battery electrolyte, gear and bearing grease, and transmission fluid are among the other lubricants and fluids that keep your car working.

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2. LUBRICATION, FLUID AND FUEL SYSTEMS: HOW TO KEEP THEM WORKING

How often should a car be lubricated and fluids replenished or changed? At a minimum, you should abide by the lubrication intervals outlined in your owner's manual. However, if you speak to people who own cars 10, 15 and 20 years old that still give trouble-free operation, you will generally find that they lubricate and change engine oil and other fluids more often than suggested by the manufacturer.

What you should know about engine oil

Oil has different characteristics which make one kind better suited for your engine than others. Characteristics are referred to as type, meaning quality, and viscosity or weight, which refers to flow properties.

The American Petroleum Institute (API) has established a grading system that designates five types of oils by the symbols SE, SD, SC, SB and SA. Only SE, SD and SC are suitable for use in automobile engines.

SE oil, which is of the highest quality and price, possesses detergents and additives that provide maximum protection against acids, oxidation, rust and corrosion, especially in engines that have a tendency to build up contaminants due to sophisticated emissions control systems. It has the high-temperature resistance necessary in later-model engines.

Engines that are in good condition, regardless of year, would benefit by using top-grade SE oil. Specifically, however, automobile manufacturers recommend the use of SE oil in 1971 to present-model vehicles because it meets their standards for oil in those model years. And you *must* use it in new cars during the warranty period to keep the warranty valid.

Oils designated SD and SC possess lesser amounts of detergents and additives and have lower high-temperature resistance. SD oil met all manufacturers requirements for engines manufactured between 1968 and 1970 and SC oil met the requirements for engines made in 1967 and earlier.

As for viscosity, it simply means selecting an oil that has certain flow

properties. During hot weather, the wrong oil may become too thin and won't provide necessary protection. During cold weather, the wrong oil would be too thick and could keep an engine from starting.

Oil viscosity is indicated by a numerical system established by the Society of Automotive Engineers (SAE). The higher the number, the higher the viscosity. This designation also shows if oil has multiviscosity or single viscosity. Different numbers separated by a hyphen, 10W-30, for example, indicate a multiviscosity oil. A single number, SAE 10W, or the same number separated by a hyphen, 20W-20, for example indicates a single-viscosity oil. In most parts of the United States, for example, a 10W-40 or 20W-40 multiviscosity oil is suitable for use all year long.

Conversely, in most U.S. regions, car owners using single-viscosity oil would have to use one kind during cold weather (SAE 20W-20, for example) and another during warm weather (SAE 40, for example).

Multiviscosity oil is generally available in SE only. Single-viscosity oil is available in SE, SD, and SC. Type and viscosity of the oil, is marked on the container.

To determine the viscosity of oil you should be using in respect to the temperature levels in your area, consult your owner's manual or the accompanying charts.

How to change oil

1. Raise the car.
2. Place a container under the oil-pan drain hole and remove the drain

MULTIVISCOSITY OIL

When Temperature Is	Use
Not above +32° F.	SAE 5W-30*
-10° F. to +90° F.	SAE 10W-30
-10° F. to above +90° F.	SAE 10W-40
Not below +10° F.	SAE 10W-30, SAE 10W-40 or SAE 20W-40

* If sustained high-speed driving is to be done, use SAE 10W-30.

SINGLE-VISCOSITY OIL

When Temperature Is	Use
-10° F. to 32° F.	SAE 10W
+10° F. to +60° F.	SAE 20W-20
+32° F. to +90° F.	SAE 30
Above +60° F.	SAE 40

Important: Select viscosity which nearly matches the normal temperature expected in the area in which the car is going to be driven until the next oil change.

plug. Allow old oil to drain completely.

3. Examine the gasket around the drain plug, and replace if it's cracked or mutilated.

4. After oil has finished draining, reinstall the drain plug and tighten it securely, but do not ram it home. You may distort the oil-pan drain hole.

5. Fill the engine through the oil filler tube with the correct type and



Engine oil change is simplest and most important of all do-it-yourself car-care jobs.

viscosity oil. Capacity differs from engine to engine, so consult the specification in your owner's manual. If this is not available, fill the engine with four quarts and check oil level on the dipstick. Add one quart at a time, if necessary, to bring the oil level to the "Full" mark on the dipstick. Don't overfill.

6. Start the engine and check for oil leaks around the oil-pan drain plug.

What you need to know about oil filters

An oil filter traps dirt and particles which oil picks up as it

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flows through the engine. Proper oil filtration is just as essential to engine longevity as good oil.

Automakers in general recommend changing oil filters at the first oil change in a car's life and every other oil change after that. During oil changes when you're not replacing the filter, always remove it and drain the dirty oil.

Most cars use full-flow, spin-on filters. "Full-flow" means that the filter receives and cleans all oil pumped from the oil pan to the engine through the oil galleries (lines). A filter has a built-in protection feature. If it becomes clogged so oil can't get through, a bypass valve opens to divert oil past the filter.

A spin-on filter is simply a filter that can be spun on and off when it's changed. However, changing an oil filter, although easy, is not as simple as this. The right way follows:

1. See if you have to lift the car to get at the filter. Cars with eight-cylinder engines usually have to be raised. One with a four or six-cylinder engine may have a filter location reached through its engine compartment.

2. Place a wide-mouth waste container beneath the filter to keep oil from dripping on the floor. If you can't loosen the filter by hand, strap an oil filter wrench around it and turn it counterclockwise. When the filter is loosened, remove the wrench and spin the filter off its seat by hand.

3. With a clean cloth wipe off the engine surface on which the filter sits to remove particles that may prevent the new filter from seating properly. If the oil-filter seat is attached to the engine block with bolts, check to see that the bolts are tight.

4. The new oil filter should be one recommended by the car manufacturer. Make sure your hands are clean and spread a thin layer of clean engine oil on the gasket of the new filter.

5. Carefully turn the filter on its seat (clockwise). Be careful not to cross-thread. When the filter comes into full contact with its seat, turn it just one-half turn more by hand.

Important: Don't overtighten! And never tighten an oil filter with a wrench. Overtightening can crush the filter base, which will ruin the component and cause an oil leak.

6. Start the engine and run it at fast idle. Check around the filter's base for oil. If there's a leak, shut off the engine and tighten the filter another one-quarter turn by hand. Check again. If a leak persists, the filter may have been damaged.

Lube job—why, when, where and how

A lubrication guide that tells which parts require lubrication, how often lubing should be done, and which lubricants to use is printed in your



Oil filter gasket should be coated with a film of clean oil before it's installed.

owner's manual. It's also in your car's service manual, which you should get from the manufacturer.

Chassis lubrication involves front suspension, steering-linkage ball joints, front wheel bearing, and checking the fluid levels of major components.

Lubricating ball joints and wheel bearings is necessary if the car is going to be maintained in a safe driving condition. Frequency depends on manufacturers' policies, which differ. Usually, it's every 6000 miles for ball joints and every 15,000 miles for front wheel bearings.

How to lubricate ball joints

Most cars have a minimum of four front-suspension ball joints—two on the upper control arm and two on the lower control arm. You will probably also find ball joints at key steering-linkage points, especially at tie-rod ends and pitman arm.

Ball joints should be lubricated with a good quality of multipurpose chassis grease. Usually, manufacturers recommend grease having a lithium base.

Here's the right way to lube ball joints:

1. Wipe area around the ball-joint plug clean. Be careful how you work around access hole in the joint. If dirt gets inside, it can ruin the joint.

2. Most access-hole plugs are screw-in metal caps you can use over and over. Remove them with a wrench. Some older models use rubber plugs that have to be pried from the hole and replaced with new rubber plugs.

3. After removing plugs, insert



Grease fittings must be kept free of dirt.

grease fittings. They are available in various sizes and shapes to accommodate every situation, so examine the setup and get the fitting which makes things easier for you, whether it is 45°, 90° or straight.

4. Attach the grease gun, which should be rated at a maximum of 10,000 pounds (or less). "Low-powered" grease guns should be used to offset the chance of rupturing a seal. If you find it tough to attach gun to the grease fitting of an upper ball joint, use a grease gun extension adapter.

5. Pump grease into the joint gently, keeping your eye on the ball-joint seal. Stop greasing when the seal begins to swell.

6. Remove the grease gun. Leave grease fittings in place or replace plugs.

Front-wheel-bearing service

1. Place automatic transmission in Park (P)—in gear, if you have a manual gearbox. Set the handbrake, raise the front wheels and check the rear wheels. Take off wheel covers.

2. If the car is equipped with front disc brakes, take off the wheel and tire assembly. Remove brake caliper by detaching retaining studs and lifting the caliper off the disc. Support the caliper on the steering knuckle arm. Don't let it hang by the brake hose.

3. At this point, wheel-bearing service for cars with disc brakes and cars with drum brakes is virtually the same. Loosen the grease cap by tapping it with a hammer. Pry off the cap.

4. Straighten legs of the cotter pin, remove it and throw it away.

5. Remove the castellated nut by hand, which exposes the adjusting nut. Take this off, too.

6. Wipe all dirt and grease from the wheel spindle. Grasp the tire and wheel assembly of a drum-brake setup, or the



Front wheel bearings should be lubricated according to manufacturer's specs.

disc of a disc-brake setup on top and bottom. Pull it toward you about one inch with a jerk. Push it back. A thrust washer and the outer wheel bearing should drop on the spindle.

7. Put the bearing and thrust washer on a clean sheet of paper or a clean, lint-free rag. Protect bearings and associated parts from dirt!

8. Place the wheel assembly or disc

CAR CARE GUIDE 2. LUBRICATION, FLUID AND FUEL

on a clean cover, outside part facing up. Put a brass drift on inner race of the inner wheel bearing and tap around circumference of the race until the bearing drops out along with the grease retainer. Throw retainer away.

9. Shine a light inside the wheel or disc and inspect the bearing cups. If either cup is pitted, scratched or nicked, knock it from its seat with a drift and install a new cup by tapping it back into place with the soft brass drift. If you replace one or both cups, replace the respective bearing(s).

10. Inspect bearings. Discard one if it shows obvious damage. The right way to handle a bearing is to hold it by its outer rim. Don't wrap your hand around the needles.

11. Put the bearings into a clean container filled with kerosene or wheel-bearing cleaning solvent. Wash them with a clean soft-bristled brush, working the solvent between the needles. Then lay the clean parts on clean paper. Let them dry.

12. Dip the bearings into clean SAE 20-weight oil. Make sure all surfaces are coated. With the bearings protected, examine them closely and look for any damage. Bearings must not be black or rusty, pitted or scratched. Spin the bearing slowly. If it binds or feels scratchy, get rid of it.

13. Whether you put bearings back into service or use new ones, lubricate them with high-temperature wheel-bearing grease. Put a glob of grease in the palm of your *clean* hand and work the bearing into the grease. See that the grease gets between the needles. Now lay the bearings aside on a clean cover and service the wheel or disc.

14. Clean the hub with kerosene or wheel-bearing solvent and let it dry. Apply a light coat of wheel-bearing grease to the hub's inner surface.

15. Place the inner wheel bearing into its cup in the hub with fingertip pressure. Dip a new grease retainer in SAE 20 oil and lay the retainer right over the face of the inner bearing. Put a grease-retainer impact tool over the retainer and give it a whack with a hammer, seating the retainer. Just to be sure, tap the retainer edge around its entire circumference with a brass drift.

16. Clean off any grease that may have dropped on the wheel or disc, and place the part back on the spindle. Put outer bearing into its cup, and install the thrust washer and adjusting nut, running the nut up finger-tight.

17. Check the wheel-bearing adjustment specification for your car and, using a torque wrench, tighten the adjusting nut to specification as you spin the wheel or disc. After tightening has been done, spin the wheel or disc to make sure it revolves freely. If it doesn't, back off the adjusting nut and readjust.

18. Place the castellated nut back



A torque wrench should be used to tighten front wheel bearings to specification.

where it belongs and install a new cotter pin. Spread legs of pin and wrap them around the nut. If legs are too long, snip off part of them.

19. Clean out inside of grease cap. Coat it with a smear of wheel-bearing grease, and put it back on.

20. Replace the caliper if you're working on a car with disc brakes.

Search for the right gasoline

Federal regulation requires that gasoline stations post octane ratings of their fuels on the respective gasoline pumps. This is confusing because octane ratings posted on the pumps appear substantially lower than the octane ratings recommended by car manufacturers in (pre-1975) owner's manuals. The following information should clear up the confusion:

Basically, there are three grades of gasoline: leaded premium, leaded regular and unleaded regular. The difference between leaded premium and leaded regular is that the premium gas possesses more lead. Lead additive is used to increase the octane rating of gasoline. A higher octane must otherwise be obtained by "reforming"—blending lighter gasoline components called "aromatics" into the base stock. Cars equipped with catalytic converters (most 1975 models only) must use unleaded gasoline to avoid rendering the catalyst ineffective.

Octane is a measure of how smoothly a gasoline burns in an engine, and therefore a measure of how likely it is that a gasoline will cause a harmful knock or ping in an engine because of uneven burning.

There are three ways to define octane; because of them confusion has arisen about the federal regulation. The three ways are research octane, motor octane, and antiknock index.

The research octane number (RON) is determined in the laboratory using a one-cylinder engine. You will find this number in your car owner's manual if your car is a pre-1975 model.

Motor octane is also a one-cylinder laboratory test, but this one is conducted under more severe conditions. The motor octane number is always lower than the research octane number for a particular sample of gasoline.

Neither research nor motor octane numbers accurately predict the actual octane performance of gasoline that's burned in your engine under road conditions. However, when the two "octanes" are averaged the result is a fairly accurate measure. This has resulted in a third way of measuring octane—the antiknock index.

Antiknock index, the numbering posted on the pump, is derived by averaging research and motor octane. The antiknock index is always lower than the research octane number given in pre-1975 owner's manuals (and always higher than comparable motor octane). Beginning in 1975, car manufacturers started recommending gasoline in owner's manuals by calling attention to the antiknock index.

Suppose your pre-1975 car owner's manual says to use gasoline having an octane (research) of 95. The motor octane of gasoline having a research octane of 95 is 87. Thus:

$$\frac{R+M}{2} = \frac{95+87}{2} = 91$$

The gasoline you try should have an antiknock index of 91 posted on pump.

When all is said and done, however, the proof of whether a particular gasoline is suited for your engine is in the use. If a gasoline causes engine knock as you accelerate up a hill in high gear, switch to a gasoline having a higher antiknock index.

What you should do for your car's cooling system

Keep an eye on the coolant level. Remove the radiator cap when the engine is *cold*. Depending on the radiator, the coolant level is from 1 to 3 inches below the top of the filler neck, but most radiators are marked to show the correct "fill level." If coolant is needed, add it directly to the radiator unless your car is equipped with a coolant recovery system.

With that system, you should not remove the radiator cap unless you have to. To check coolant level, just look right through the plastic tank. Level should be maintained at the indicated mark. If coolant is needed, remove cap of the recovery tank and add coolant to the tank—not to the radiator. Ethylene glycol antifreeze is the



Coolant hydrometer checks protection.

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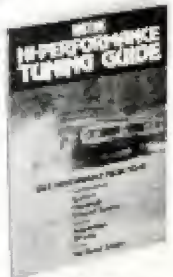
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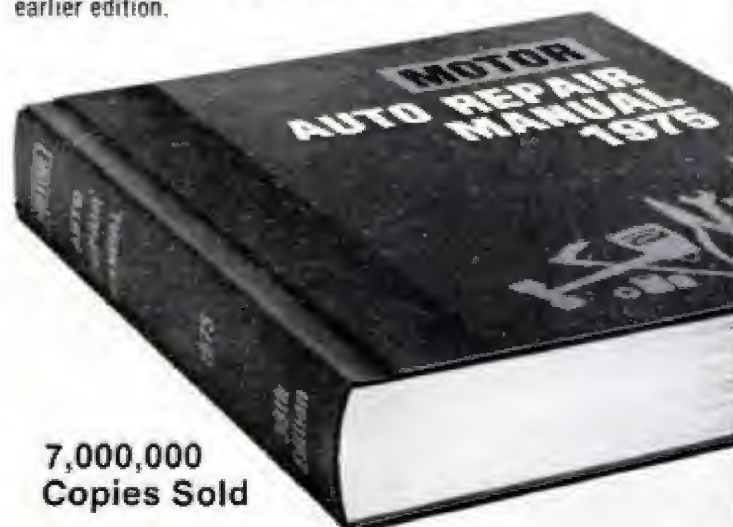


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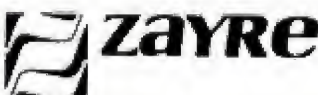


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CAR CARE GUIDE 2. LUBRICATION, FLUID AND FUEL

only coolant to use. It contains rust inhibitors, for example, to protect the system. Other coolants—water and methyl alcohol—do not.

A 50-50 mixture of a good ethylene glycol and water (ethylene glycol must be mixed with water) will protect an engine against freezing to -34°F . It has a boiling point of $+264^{\circ}\text{F}$.

Ethylene glycol should be drained from a cooling system every two years and fresh coolant added. After this period of time, inhibitors wear out.

When replacing coolant, flush the cooling system to clean out dirt and corrosion, and to uncover parts that may be failing. Here's how to do it:

1. With the engine cold, inspect all hoses—upper radiator, lower radiator, water-pump bypass (if used) and heater. Squeeze each. Get rid of any hose that is cracked, mushy, shows weather checking or has white deposits around clamps (indicates a leak, so be sure the clamp hasn't lost strength, too).

2. Drain the cooling system by removing the radiator cap and opening the petcock in the radiator's lower tank. Also remove the cylinder-block drain plugs for complete draining. There are usually two plugs in a V8 engine—one in Fours and Sixes.

3. Close the petcock and replace the drain plugs when coolant has drained fully. Fill the radiator with water and chemical radiator flush. Follow instructions on the flush's container.

4. Drain the system again. If fluid coming from the petcock and drain plug holes is sludgy, allow complete draining to take place. Then reinstall drain plugs, but keep the petcock open. Remove the thermostat, place a garden hose in the radiator filler neck and turn it on so there's a good, steady flow of water.

Start the engine and let it run as the water flushes particles from the cooling system. Stop when water coming from the petcock runs clear.

5. Check the thermostat and if it is not functioning properly, replace it.

6. Fill the radiator with coolant.

7. Clean debris from the radiator by brushing fins with a long-handled soft-bristle brush, but be careful not to damage the fins.

8. Adjust the drive belt to provide a play of $\frac{1}{2}$ to $\frac{3}{4}$ inch when you push in on it midway between the pulleys. Replace a belt that is cracked, frayed or glazed.

9. Run the car for a day or two. Then, with the engine cold, check to see if coolant level has dropped. If it has, there is a leak that should be found and fixed. It may be caused by a bad radiator pressure cap, bad hose, hole in a radiator tank, weak water pump or leak in heater or heater hose.

A car's other important fluids

Other fluid levels that should be checked periodically are battery

electrolyte, brake fluid, steering fluid, differential lubricant and transmission fluid.

■ **Battery electrolyte** should be checked at least once a month. Add water if it's needed.

Battery manufacturers agree that the best water to use is distilled water which does not contain minerals that can shorten battery life.

Manufacturers say that if tap water is used, it should be free of minerals. That advice is kind of tough to follow, because few tap water sources today are mineral-free. But you can make your own mineral-free water by using a device designed primarily for filtering tap water used in steam irons. The device is available in hardware, appliance and auto supply stores.

Do not overfill a battery. There is usually a mark in each cell that should not be exceeded. Excess water is expelled through vent holes, spreading itself over the battery and causing corrosion that hastens discharging.

■ **Brake fluid.** According to the National Highway Safety Administration, "the careful choice and use of hydraulic



Master cylinder cover is easily removed for checking the level of brake fluid.

brake fluid is absolutely necessary if dependable and safe braking performance is to be maintained."

Owner and service manuals list the type of brake fluid to use. This advice should be followed.

The brake-fluid level, which you can see after removing the master cylinder cover, should be checked when you change the car's engine oil, at the first sign of brake-pedal fade or when the dash-brake warning light (if the car has one) flashes. Unless the brake system is leaking, there should be little, if any, loss.

Important: If you must add brake fluid (normal level is $\frac{1}{2}$ inch below the top of the master cylinder), do not retain unused fluid for use in the future. Brake fluid that is kept for longer than two days in an open container will absorb moisture and it should then be considered as contaminated.

■ **Steering fluid** of every car without power steering and some with power steering can be checked by removing a steering-gear-lubricant filler plug,

which normally is right on top of the steering gear.

When you lubricate the car, unscrew this plug. Fluid (gear oil) should be covering the gear and should be almost



Power-steering fluid should be checked regularly and topped off as needed.

to the filler hole. Add gear oil of the weight specified by the manufacturer, if it's needed.

Check the power-steering fluid level (once a month is not too often) with the engine warm. Park on a level surface and with the engine running turn the steering wheel full left and then full right several times. Do not keep the wheel at either extreme for more than a few seconds.

Shut off the engine. Clean dirt from around the power-steering reservoir cap and remove the cap. Fill the reservoir if it's low, but if it's exceptionally low, there might be a leak in the power-steering system.

■ **Differential lubricant.** Remove the differential oil plug. The oil level should be on line with the bottom of the drain-plug hole. You won't be able to see it, but you should be able to feel it with your finger.

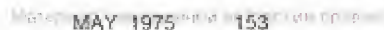
If lubricant has to be replenished, add a multipurpose gear oil with a suction gun. The weight of the lubricant should be determined by consulting the manufacturer's lubricant instructions.

Cars having positive traction differentials must not be filled with conventional differential gear oil. A special lubricant that keeps friction clutches from chattering as they engage must be added.

■ **Transmission fluid.** If your car has a manual transmission, remove the level plug when the car is being lubricated. The plug is probably on one side of the transmission case. Fluid level should align with the bottom of the hole. If it doesn't, add a multipurpose gear oil specified by the manufacturer.

The way to check automatic transmissions was discussed in Section 1. If fluid has to be added, you'd better use the kind recommended by the manufacturer.

The two types are Dexron and Type F. Generally, Ford recommends Type F. AMC, Chrysler and GM say to use Dexron. ★ ★ ★

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We've got your plug.

3. ELECTRICAL AND IGNITION SYSTEMS: HOW TO KEEP THEM WORKING

Every car owner should own a hydrometer to make a simple specific gravity test of battery electrolyte. Specific gravity refers to percentage of sulfuric acid in the battery electrolyte. A drop in specific gravity warns of a battery that may be losing its ability to maintain a charge.



Battery electrolyte specific gravity is measure of charge and is checked with a hydrometer. This type has built-in thermometer to compensate reading according to ambient temperature.

You can buy a battery test hydrometer for a few dollars. Get one with a built-in thermometer to compensate for electrolyte temperature. Then you won't have to take separate temperature samples and interpolate readings.

Test specific gravity this way:

1. See that electrolyte in each cell is at the level mark. If you have to add water, run car at fast idle for at least 15 minutes before taking the test to get fresh water and acid mixed.
 2. Remove vent caps. Draw electrolyte into the hydrometer tube from the first cell. Not too much—the float in the hydrometer should ride free.
 3. Hold hydrometer at eye level and read the scale.
 4. Return acid to the cell. Take readings in other cells the same way.
 5. Compare each reading with others. If one or more shows an .050 specific gravity point deviation (or more) from the others, the low cells are dying. The battery won't last too much longer.
- If overall specific gravity is below 1.225 (full charge is 1.260 to 1.280), slow-charge battery and test again.

If specific gravity doesn't rise much above 1.225, battery is not holding a charge and should probably be replaced.

Battery life may be extended by cleaning. Acid and dirt on the case can cause a battery to self-discharge. To clean it, remove ground cable first—then the positive cable. This order precludes sparking—sometimes dangerous because a battery constantly gives off explosive hydrogen. So, no smoking!

Take battery out of the car and put it down. Tighten vent caps and cover with masking tape. Now scrub battery with a baking soda and water solution. Flush with fresh water from a hose. Repeat until a fresh application of the soda no longer causes "fizzing."

Clean cable terminals with a wire brush and wash the battery holder as you did the battery. Return the battery and reconnect cables tightly, *positive cable first*. Apply a thin coat of white grease to the terminals.



Wire-brush tool makes cleaning of battery posts a flick of the wrist—literally.

Sparkplugs: the tip-off to complete combustion

Disconnect sparkplug cables by grasping and twisting the boots—not the cables. Use cable-disconnect pliers, if you have them.

Mark each cable with the cylinder number it serves to assure that each will be reconnected properly. Write numbers on pieces of masking tape and wrap the tape around the cables.

Reconnecting cables to the wrong cylinders causes crossfire—the engine



Cable puller prevents damage to cables.

fires out of turn, placing great stress on internal parts and causing severe damage.

After cables are disconnected, blow dirt from around sparkplugs and remove plugs with a deep socket. Identify each plug to its cylinder by writing its number on the plug with a felt marker. Then, if plugs will be reused, they will be returned to the correct cylinders. This also lets you determine if a problem exists in a particular cylinder by examining its plug.

Examine each plug for abnormal conditions as we discussed in Section 1. If they are not damaged and have not exceeded their useful life, they can be serviced and returned to the engine. Usually, it is advisable to replace sparkplugs that have seen 15,000 to 20,000 miles of use.

To service used plugs, check the following points:

1. With the bending-tool portion of a sparkplug gauge, carefully bend the side (ground) electrode away from the center electrode; not too much—just enough to get the tools you're using between the two. *Caution:* Use only this bending tool to bend the electrode. Pliers and the like will damage plugs. Also, take great care to see the center electrode is not struck accidentally. Hitting it may cause damage that will necessitate discarding the plug.
2. Scrape foreign deposits from the firing end with an old hacksaw blade that's been ground down at one end to a 1/8-inch-wide taper.
3. Wash the whole plug in mineral spirits or kerosene. Use a soft rag or



Playing it by ear is no way to get over the rough spots.

Just hearing a knock, ping or rattle isn't enough. You have to know what's causing the sound before you can fix the problem. RAC test and tune equipment lets you find out exactly what's going on inside that automobile engine. You'll find out what's causing the problems you hear; and you'll prevent a lot of problems before you can hear them.

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CAR CARE GUIDE

brush to remove dirt. Allow plug to dry on a clean sheet of paper or rag.

4. Slip an ignition-point file between the electrodes and make two or three passes to file them clean and bright.

5. Examine threads for carbon and scale. Clean threads with a small wire brush. Dirty threads can keep a plug from seating itself properly in the engine, resulting in compression loss.

6. Gap your cleaned plugs to the specification provided in service data. This and other tune-up data are listed on a tune-up decal pasted in the engine compartments of most cars since 1969.

Use a sparkplug gauge only. An ignition point feeler gauge, which is flat, will give inaccurate results.

Proper gap is attained when there is a slight resistance as you move the gauge between the two electrodes. Adjust this space (gap) by bending the ground electrode only.

7. If sparkplugs have gaskets, it is best to discard them for new ones, but first make sure you can get them. They have been in short supply. If new ones aren't available, use the old gaskets.

8. Wipe threads of sparkplug ports clean with a rag dampened in mineral spirits and screw each plug back into its respective port by hand until it's finger-tight. If you have a torque wrench, tighten plugs to the torque specified in your service data.

9. If you have no torque wrench, run plugs in finger-tight. Then, with a deep socket of proper fit (so plugs aren't damaged), tighten each a half turn. Start the engine and feel around each plug port, if you can, for "puffing" that indicates a compression leak. If you find it, tighten plug another quarter turn and check again.

Caution: Overtightening plugs is as bad as leaving them too loose. A plug run up too tight may be struck by the piston on its upstroke and also has a tendency to "freeze" in the port.

When new plugs are needed

Sometimes the sparkplug recommended by the maker is not the one to use. It is designed to accommodate a more or less equal amount of idling, slow-speed and highway-speed operation, generally called "normal" operation.

However, if your driving is weighted in favor of one over the other, the "normal" sparkplug probably shouldn't be used.

The right sparkplug for an engine is the one that best meets the thermal conditions that exist most often inside the cylinder head. There are "hot" plugs and "cold" plugs.

"Hot" and "cold" are terms to be judged in relation to engine heat and in respect to other plugs in the same scale that fit the engine. A sparkplug is either hotter or colder than the one next to it in the scale.

3. ELECTRICAL AND IGNITION



Sparkplug at top is "hotter" than the one below. Note difference in insulator length.

Whether a sparkplug is "hot" or "cold"—that is, its heat range—is determined by the length of its lower insulator. Plugs with long insulators retain heat—they are hot plugs. Plugs with short insulators get rid of heat rapidly—they are cold plugs.

If a sparkplug is too cold for an engine, it can't burn away deposits that form as a result of combustion. Deposits can build up and short-circuit the plug, resulting in engine misfire.

If a sparkplug is too hot for an engine, it can start glowing and cause premature combustion, or preignition—one of the most serious things that can happen. Preignition can ruin an engine.

Generally, plugs that are colder than normal are used when combustion-chamber temperature is higher than normal, as it would be when the car is pulling a trailer or is being driven at continuous high speeds. Plugs hotter than normal are used when combustion-chamber temperature is lower than normal, as it would be when a car is driven primarily in stop-and-go city traffic.

The way to determine the specific sparkplug your engine should use is to begin with the one recommended by the manufacturer. Drive the car for 1000 miles. Then, remove some of the plugs for examination.

If insulator tips look white, plugs are too hot for the engine. Switch to the next colder one in the scale and retest.

If insulator tips are coated with fluffy carbon deposits, plugs are too cold for the engine. Switch to the next hotter one in the scale and retest.

If the insulator tips are gray or light tan, the plug is the right one.

Don't forget: Whenever you install new sparkplugs, you have to set the electrode gap to specification.

Keeping the avenues open

Sparkplug cables are often overlooked during a tune-up, and many engines suffer. The best tune-up in the world can't overcome misfiring caused by current leaking from damaged cables before it can reach sparkplugs.

Reconnect cables to their correct cylinders, pushing them firmly on sparkplugs. No two cables of plugs that

fire one after another should run parallel to each other. Crosstire may result.

Get rid of cables that obviously are brittle and cracked. But even if cables appear in good condition, they should be tested for leaks. You will need a length of jumper wire with alligator clips on each end and a long screwdriver with an insulated handle.

Connect one alligator clip to the screwdriver and the other clip to a clean ground on the engine. Start the engine and let it idle.

Remove one cable from a sparkplug. Holding the tip of the screwdriver close to the cable, you move it up and down over the entire length of cable. If a spark jumps to the screwdriver from the cable, the cable is leaking.

Test all cables.

Keeping the ignition system firing

Conventional ignition tune-up involves inspecting and cleaning ignition parts, adjusting distributor-point gap and dwell, and adjusting ignition timing. Here's how to do this by the numbers:

1. Remove the high tension cable from the coil tower by grasping and twisting the boot—not the cable. Inspect the cable's terminal and look in the tower. Are the leads black? If so, clean both. The one in the tower should be cleaned with a distributor-cap cleaning tool.

If either terminal is badly eroded, replace the part. Prevent the arcing that causes this problem by seeing to it that the cable is firmly connected to the coil tower.

2. Clean off the coil housing and inspect it. If the housing is cracked or the tower is damaged, replace the coil.

3. Check primary wires going to the coil's terminals. If insulation is damaged, replace wires. Make sure that wires are tightly connected to the terminals.

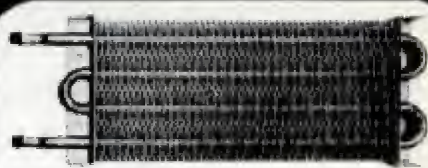
4. Get a good idea of overall ignition performance by removing a cable from a sparkplug. If the boot is not molded to the cable, pull it back to reveal the terminal. Then, while you hold the wire with a pair of insulated pliers, place the terminal about 3/4 inch from a clean ground on the engine.

If the terminal is covered with a



Inspect distributor cap closely.

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CAR CARE GUIDE 3. ELECTRICAL AND IGNITION

molded-on boot, do not break the bond. Instead, insert a screwdriver in the boot so it makes contact with the terminal and hold the screwdriver to ground. Like the pliers, the screwdriver should have an insulated handle so you can grasp it without getting a shock.

Have someone start the engine. You should see a strong blue spark cross the gap to ground. If the spark is weak and yellow or orange, there's a problem somewhere in the ignition circuit.

The problem may be a weak battery (this should have been discounted by now), corroded or loose cables and wires (this, too), or a faulty part in the distributor.

After the distributor is checked, as detailed below, and a retest still reveals a problem, then you can conclude it's being caused by a bad coil. You can't tell for sure without a coil tester, but you can pretty much assume that the coil should be replaced.

5. Remove the distributor cap and wipe it clean. Examine the outside. If the cap is cracked, chipped or shows carbon tracks, replace it. A carbon track is a path caused by a hairline crack through which electricity leaks.

Turn the cap over and look inside. If

one of the metal terminals is broken or badly burned, or if there is a carbon track, replace the cap. If terminals are slightly corroded or blackened, polish them with a piece of fine sandpaper.

Now remove one cable from the cap by twisting and pulling the boot. Look inside the tower. If there is a heavy buildup of corrosion or carbon, or if the tower is damaged, replace the cap. If the tower is okay, clean it with a distributor-tower cleaning tool.

Reconnect the cable securely and examine all other towers the same way.

If a distributor cap has to be replaced, you have to install cables in their correct towers to prevent cylinders from firing out of turn. Keep the old cap hooked up and put the new cap alongside so markings and features of both caps are aligned. Now just transfer each cable in turn from its place in the old cap to the respective tower in the new cap.

6. Keep the cap off the distributor and remove the rotor. If its metal contact is corroded or broken, or if its body is cracked, replace the part.

7. If your distributor has a radio frequency shield that insulates the car's radio from ignition that may

cause interference, remove it. Test distributor springs and counterweights by turning the distributor shaft in the direction of rotation. Release shaft. It should snap back to its original position. If it's sluggish, springs are probably worn, and the distributor should be overhauled.

To determine the direction of shaft rotation, crank the engine. The way the distributor shaft turns is the direction of rotation.

8. Test the distributor vacuum advance by pressing your fingers against the back of the breaker-point assembly and pushing the base plate in the direction *opposite* to shaft rotation. Release it. The base plate should swivel quickly and without binding back to its original position. If it doesn't, replace the vacuum advance.

9. The breaker points should be inspected, which is often tough to do with the points mounted in the distributor. If you have to, remove points and spread them apart. They should have a grayish tint, with maybe a slight roughness or pitting, but nothing major.

If they're okay, pass a clean ignition-point file between points and make one pass only. Overfiling destroys

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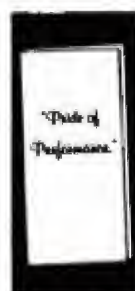
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alignment. Moisten a clean cloth with mineral spirits and wipe off residue.

If points are badly worn or burned, replace them. Replace the condenser, too. However, if points have been in use only for a short time, then there's a problem somewhere in the ignition system that's ruining them. Find and fit it before new points are destroyed.



Tach-dwell meter is necessary instrument for doing your own tune-up job.

A likely candidate for blame is an ignition ballast resistor which may have opened up.

10. Reinstall points and set gap to manufacturer specification (consult service data or the tune-up decal in

engine compartment). Set rubbing block of the movable breaker point on a lobe of the distributor cam by cranking the engine in brief spurts. Point gap is adjusted in one of two ways, depending on the kind of distributor you have.

Some assemblies are equipped with an adjusting screw that is turned with an Allen wrench. Others are adjusted by twisting a slot next to the assembly mounting screw and then tightening the screw.

Set gap with a feeler gauge, which should be clean to avoid transferring dirt to points, which will cause them to burn.

Hold the gauge parallel to points. Twisting the blade will widen the gap. Points are set properly when there's a slight resistance as you slide the gauge back and forth between points.

11. If distributor is equipped with a wick-type lubricating pad next to the cam, replace the pad with a new one. Don't reverse and reuse it. The cam won't receive adequate lubrication.

If there is no pad, apply a single drop of distributor-cam lubricant to one cam lobe. No more. Too much lubricant will splash and settle on distributor points, causing premature failure.



Timing light allows you to make perfect adjustment of ignition timing.

Setting point dwell

It is now time to set point dwell—that is, to fine-tune the point setting.

Dwell refers to the period of time that distributor contact points are closed. Instructions with all dwell/tachometers tell you exactly how to set dwell to specifications.

It's time to time

Instructions with your timing light tell you exactly how to use it, and your owner's manual or service manual lists the timing spec you need. Set the ignition timing and your tune-up's complete. ★ ★ ★

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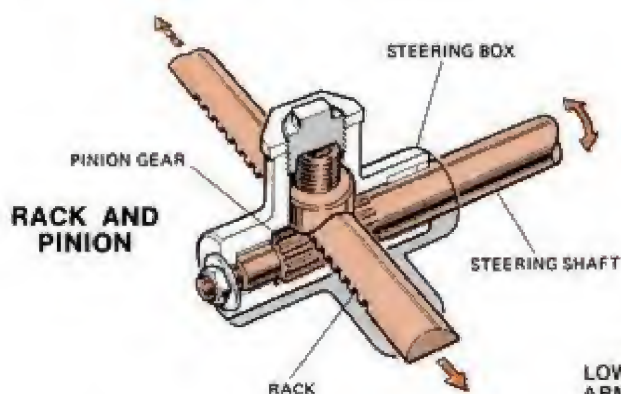
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*Don't forget—the safety of your tires is also affected by air pressure, wear, load, and operating conditions.

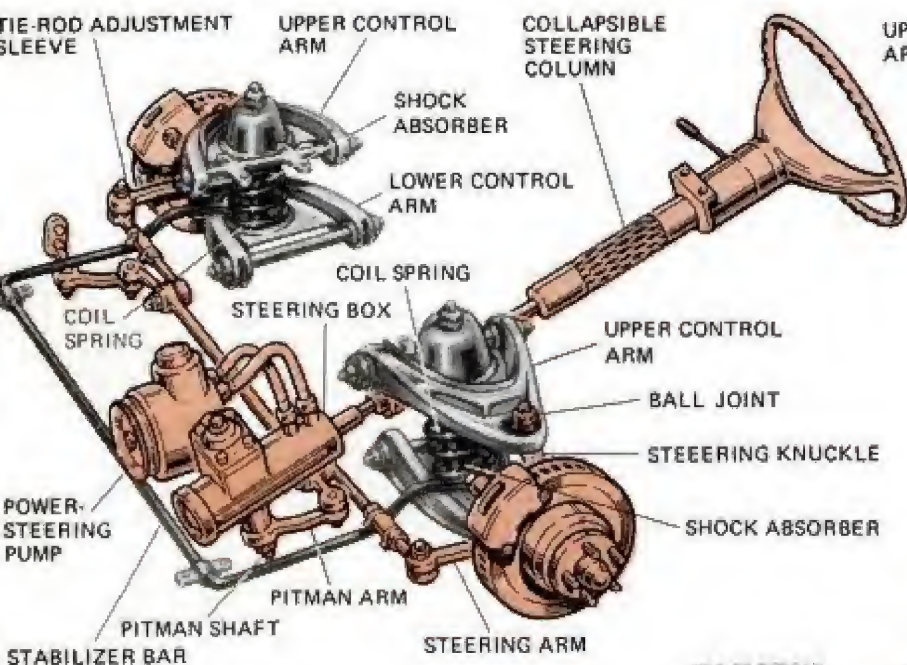
Firestone

It's too much tire to turn down

4. SUSPENSION AND STEERING SYSTEMS: HOW THEY WORK

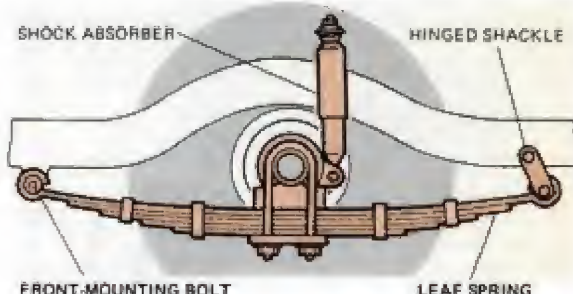


FRONT SUSPENSION AND STEERING

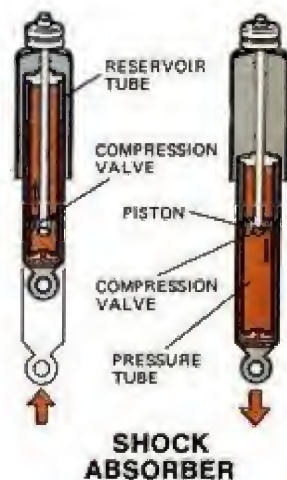
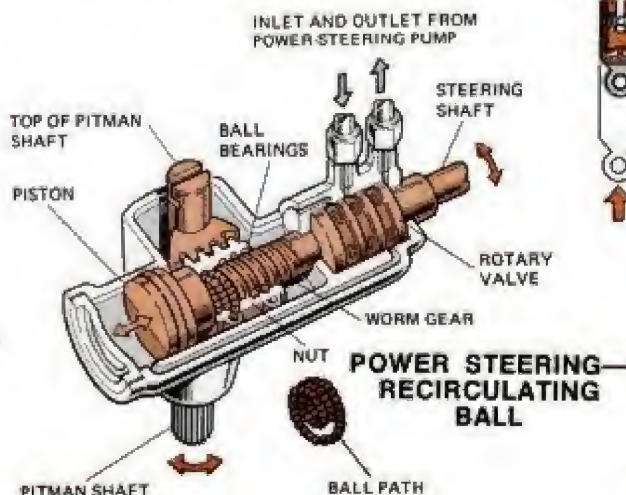
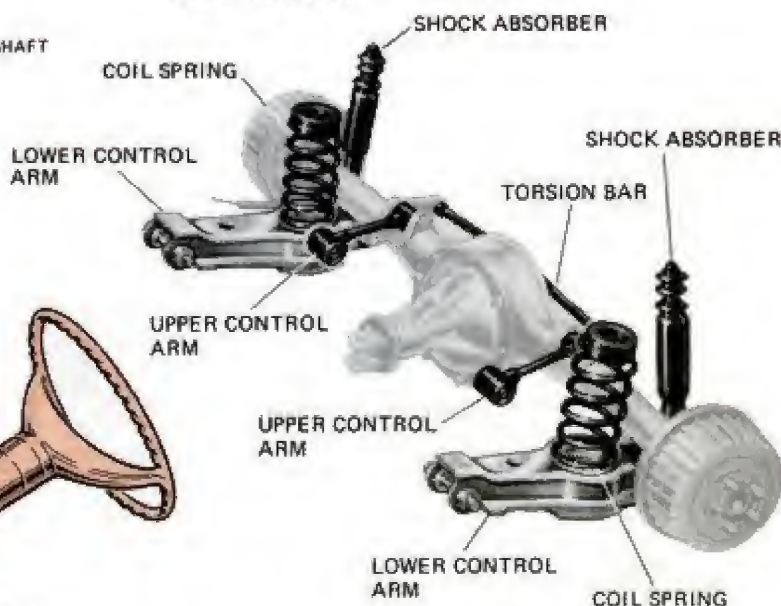


The simple steering wheel is only the tip of an iceberg; on opposite side of the firewall are other components in your steering system: steering-gearbox with rack and pinion or recirculating-ball gear arrangement, power-steering pump; safety steering column that collapses in a frontal collision; complex linkage connecting front wheels which are independently suspended by upper and lower control arms (sometimes called A-arms because of their shape). Rear wheels are connected to an axle using coil or leaf springs. Shock absorbers, used at all four wheels, stop the car from bouncing up and down after hitting bumps.

REAR SUSPENSION—LEAF SPRING



REAR SUSPENSION—COIL SPRING





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CAR CARE GUIDE

4. SUSPENSION HOW TO

A failure in the steering or suspension system will usually "tell" you it exists.

The one "message" that is sent most often when a steering or suspension problem develops is vibration, which is a shimmy in the front wheels. This is a continuous shaking sensation felt in the steering wheel, floor or seat even on a smoothly paved highway.

If the condition is vibration, it will occur at one driving speed, usually from 50 to 70 mph, and it will continue as long as you drive at that one speed. However, it may disappear when that one speed is exceeded, and it will always disappear when you drop below that speed.

Don't confuse vibration with front-wheel tramp (tire thump). Front-wheel tramp is a cyclical thump-thump-thump sensation which is felt at about 25 mph. Some problems causing vibration may also cause front-wheel tramp, particularly bad shock absorbers and out-of-balance (eccentric) tires.

Steering and suspension problems that cause vibration are worn shock absorbers, loose steering linkage, worn ball joints and a misaligned front end. These and important data about power-steering systems will be discussed in this section of the *Car Care Guide*.

Other conditions causing vibration are improper tire pressure, tire bulge, loose wheel nuts and out-of-balance wheels. These areas are dealt with in the next section on Wheels and Tires.

Still other problems that can create vibration are worn or loose front-wheel bearings (discussed in the section on Lubrication) and driveshaft problems (discussed in the section on Engine and Drive Train).

How to check shock absorbers

You can use this test to determine if a shock absorber has gone bad:

Push up and down on the bumper at each corner of the car several times. Increase the length of the stroke with each push. Then, release the bumper at the bottom of a down stroke.

If up-and-down motion stops abruptly, the shock absorber in that corner is probably in good condition. However, if the car bounces two or more cycles, get under and examine the part.

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AND STEERING SYSTEMS: KEEP THEM WORKING

If fluid is leaking and running down the case, the part is shot. Replace it.

Next, tighten upper and lower fastening bolts and try shaking. If the part is loose, the bushing should be replaced, if possible. If not, the shock should be replaced.

It's not necessary to replace all



Check shock absorbers for leaks.

four shock absorbers if only one shows signs of wear, but shocks on the same axle should be replaced as a pair.

How to remove shock absorbers

1. Clean dirt and grime from both upper and lower mounting bolts. Apply a goodly amount of liquid "nut-buster" or penetrating oil to fasteners, and let it soak in for several minutes. The hardest part of this job is loosening fasteners.

2. If the car has coil springs, place a jack beneath the lower control arm (or on rear axle) near the spring and jack corner so spring pressure is taken off the shock and put on the jack.

3. Remove the lower fastening bolt and let the shock hang loose. If it is not inside a coil spring or A-arm so you can grasp it, grab hold and force unit in and out, testing its resistance. It should be considerable. But if the shock moves free and easy, replace it.

If you doubt that shock resistance is adequate, compare it to a new unit.

If shock absorbers must be replaced, simply remove the upper fastening bolts.

4. If your shock absorbers are inside coil springs or A-arms, an on-the-car resistance test can't be performed. Remove upper and lower mounting bolts, remove the shock and spring from the

car, separate the two, mount the shock in a bench vise and test resistance.

If you can't see upper fastening bolts from beneath the car, you will find them beneath the hood at the wheel wells. This is true for many imported cars, which have the McPherson front-suspension system.

5. If shock absorbers are okay, but the bushing is bad, causing looseness and maybe a clunking noise when the car hits bumps, you may be able to replace the bushing and save the shock.

How to inspect a steering linkage

If a part of the steering linkage suffers damage or loosens up, vibration will occur. It may be accompanied by some other condition, such as loose steering, jerky steering, side-to-side wander (vehicle instability) or rattling.

There is a simple but effective way of determining whether there's a bad part in the steering linkage. With the car lifted, examine each part to see if any are bent. Replace a damaged part.

Now grasp each part in turn—tie rods, pitman arm, idler arm relay rod—and try to shake it. If it moves at all, replace it.

The danger of bad ball joints

The weight of your car virtually rides on the ball joints. Although suspension ball joints are very reliable, they do wear out and may get damaged. They should be checked periodically, and a warning sign of trouble should never be disregarded.

Vibration is obviously one warning sign of ball-joint trouble, especially if vibration occurs when the car hits a bump. Other warning signs include excessive play in the steering wheel,



Check steering linkage for looseness.

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CAR CARE GUIDE

vehicle instability, and crunching or squeaking noises from the front.

How to test ball joints

Automobile manufacturers recommend that you test ball-joint axial play to see if the joint exceeds specified wear. Axial play refers to up and down movement of the ball in its socket.

Begin checking front suspension ball joints (there are none in the rear) by releasing the load on the joint. Load on a ball joint is applied in one of two ways: compression or tension.

A compression-loaded ball joint has forces placed on it that push the ball against the top of the housing. Conversely, with a tension-loaded ball joint, force on the joint works to pull



Test ball joints by taking pressure off primary load-carrier, here the lower ball joint of a torsion-bar suspension system.

the ball out of the housing.

To take the load off a ball joint you're testing, you must see if the joint is compression or tension-loaded. Look at the four illustrations on the facing page and compare them to the underside of your car.

Fig. 1 shows the coil spring on top of the lower control arm. Both upper and lower ball joints are tension-loaded, with the lower ball joint being the primary load-carrying member.

In other words, the lower ball joint takes practically the whole load, and it will fail first. The upper ball joint is the follower member and need not be tested unless the lower ball joint is found to be faulty and must be replaced. With the lower ball joint out of the car, it's possible to test the upper ball joint.

To relieve pressure on the lower



Jack under cross member takes pressure off upper, compression-loaded joint.

4. SUSPENSION AND STEERING

ball joint, raise the wheel by placing a jack beneath the lower control arm as close as possible to the centerline of the coil spring.

Figs. 2 and 3 show that the upper ball joints are tension-loaded, and lower ball joints are compression-loaded. In Fig. 2, the system shown is coil-spring suspension. The setup seen in Fig. 3 is torsion-bar suspension. The way you relieve pressure on the primary load-carrying member, however, is the same for both.

The lower ball joint is the primary load-carrying member. Raise the wheel by placing a jack as close to the wheel as you safely can. This takes the load off the ball joint.

Another suspension configuration is seen in Fig. 4. The coil spring is positioned on top of the upper control arm, with the upper ball joint being compression-loaded and the primary load-carrying member. The lower ball joint is tension-loaded.

Pressure on this setup is a bit more difficult to relieve. Since the coil spring is mounted on the upper control arm, the force of the spring against the control arm must be locked out, so the load can be taken off the upper ball joint. Place a support wedge between the upper control arm and front cross member, and raise the wheel by positioning your jack beneath the cross member.

How to measure ball-joint axial play

1. Jack the wheel up high enough to relieve pressure on the car's rebound bumpers, which are rubber grommets that are mounted on the frame to absorb shock. If pressure on the rebound bumpers is not relieved, the bumpers will place a load on ball joints, causing inaccurate test results.

2. Set up a dial indicator so its activating button touches the bottom of the wheel. The dial indicator must be able to record thousandths of an inch. You can buy one from an auto store.

3. "Zero" the dial indicator and place a pry bar beneath the wheel and tire assembly. Force the wheel and tire up, noting the amount of axial movement recorded by the indicator.

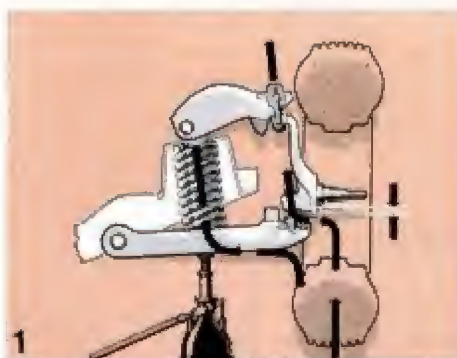
4. Consult manufacturer service data to establish the manufacturer's allowable amount of ball-joint axial play. Generally, though, any ball joint exhibiting in excess of .050-inch play should be replaced.

Importance of front-end alignment

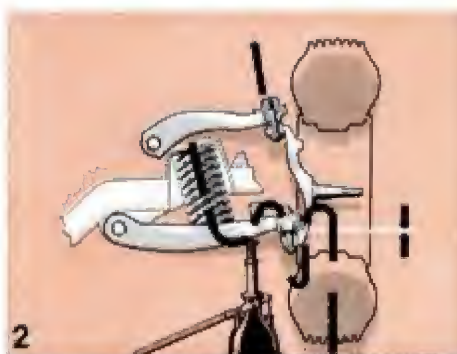
Vibration is one indication that your car's wheels are out of line. Another is a tendency by the car to pull to one side on a level road when you let go of the steering wheel.

A car which has a front end out of alignment also has a tendency to wander and weave over the road, requiring constant steering correction. There are other indications: Tire squeal on turns

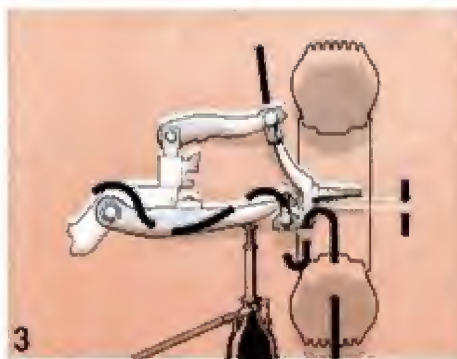
Taking load off ball joints



1 Upper, lower ball joints are tension-loaded. Lower joint is primary load carrier.



2 Upper ball joint is tension-loaded; lower, compression-loaded, is primary load carrier.



3 Upper ball joint is tension-loaded; lower, compression-loaded, is primary load carrier.



4 Upper ball joint, compression-loaded, is main load carrier. Lower is tension-loaded.

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CAR CARE GUIDE 4. SUSPENSION AND STEERING

and failure of rear wheels to track with front wheels are two. A third is unusual tire wear, especially of inside or outside tread, but let's hope you find and correct a misalignment before it starts rubbing away rubber.

Definitions you should know

Front-end alignment refers to the correct relative position of the front wheels to obtain a true, free-rolling movement over the road without scuffing, dragging or slipping. Five angles determine wheel alignment: camber, caster, toe-in, turning radius (toe-out on turns) and steering-axis inclination.

Camber refers to the outward or inward tilt of the wheel. It's measured in degrees, which represent the amount that the centerline of the wheel is tilted from true vertical.

Positive camber is when wheels tilt outward at the top, and negative camber is when wheels tilt inward at the top. Your manufacturer's front-wheel alignment specification spells out whether wheels should be set for positive camber or negative camber by the letter P or N, respectively, or by the symbol + or -, respectively. If neither letter nor symbol is present, set wheels for positive camber.

Camber is adjusted by adding or subtracting shims at the upper control arm shaft or by turning eccentric adjusting bolts. A gauge attached to the wheel tells when the camber setting is brought within specification.

Caster refers to the backward or forward tilt of the spindle support arm at the top of the wheel. Caster is a directional control angle measured in degrees showing the extent to which the centerline of the spindle support arm is tilted from true vertical.

Positive caster (P or +) is the backward tilt of the spindle support arm at the top. Negative caster (N or -) is the forward tilt of the spindle support arm at the top.

Correct caster allows the wheels to maintain a straight-ahead position and to return to a straight position from a turn. It also helps offset the effects of the crown built into most of the nation's roadways for drainage.

The caster of your car may or may not be adjustable. However, caster should still be checked, because faulty caster often signifies damage to the spindle support arms, which should be inspected and replaced, if necessary.

Excessive caster causes a car to pull toward the side having the least

amount of caster. It may also produce hard steering, road shock and shimmy.

Not enough caster causes a car to wander and weave.

Toe-in refers to the shorter distance between the front wheels and that distance separating the rear of the front wheels. **Toe-out** (not to be confused with toe-out on turns called "turning radius") refers to the greater distance between the front of the front wheels and the rear of the front wheels.

Toe-in (and toe-out) is the primary front-end alignment angle affecting tire wear. The purpose of adjusting the angle, measured in inches, is to compensate for wear in the steering linkage that occurs as a car ages.

Toe-in (and toe-out) is measured with a toe gauge; the adjustment is usually made by turning tie-rod adjusting sleeves. Rear wheels should also be checked for correct toe adjustment, since excessive toe-in or toe-out in the rear indicates a damaged part.

Steering axis inclination refers to inward tilt of the spindle support arm at the top. This is a directional angle measured in degrees. It indicates how much the spindle support centerline is tilted from true vertical.

Correct steering axis inclination aids

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steering stability and establishes a pivot point about which wheels can turn easily.

Turning radius (toe-out on turns) is an angle which is measured in degrees. It refers to the amount that one front wheel turns in relation to the other.

When turning radius is adjusted correctly, the front wheels roll freely on turns. This angle depends for its "correctness" on other alignment angles. If they meet specification, the turning radius will also meet it unless the steering arm is bent.

Overcoming a power-steering problem

When your power steering isn't acting as it should, steering suddenly becomes a tussle. Noise, binding or shimmy occurs when you turn the wheel.

Here is the way to troubleshoot a power-steering problem. Naturally, there are some tasks that you can do:

1. Check tire pressure. Make sure tires are inflated to spec since low tire pressure can cause hard steering.
 2. Check drive-belt tension since a loose belt will slip and lead to a lack of power assist, intermittent assist and noise. This is a most common cause of power-steering problems.
 3. If a noise is coming from the power-steering pump and fluid reservoir, don't decide hastily that the pump is bad and should be replaced. To test, let the engine idle and pour water over the drive belt. If the noise ceases or changes pitch, it confirms that noise is being caused by the belt or pulley.
- If water has no effect on noise, shut off the engine and loosen the belt that drives the power-steering pump only. Start the engine. Now, if there is no noise, you can conclude that the trouble is the pump.

If noise continues with the drive belt loosened, then it's being caused by the alternator or water pump.

If the drive belt is a common one—driving components other than the power steering pump—the latter part of this test cannot be performed.

4. Check the power-steering fluid level. Low fluid level leads to hard steering, intermittent power assist and noise.

5. If fluid is needed frequently, there is a leak. To test, clean off hydraulic lines, and the pump and fluid reservoir. With engine idling, turn the steering wheel all the way to the right and then all the way to the left, but don't keep the wheel at either extreme for more than a few seconds.

Turning the wheel forces hydraulic fluid through the steering system under extreme pressure and will cause fluid to leak from a defective part. Examine hydraulic lines, pump, fluid reservoir.

Leaks occur usually through split hoses and at metal hose connections. If a hose is leaking, replace it.

If the leak appears at the pump and fluid reservoir, seals may be bad or the housing itself may have ruptured. The part should be replaced.

6. If the car is difficult to steer only at low speed, the problem is probably a defective control valve. This valve provides full hydraulic pressure at lower speeds when steering is more difficult. At higher speeds, when the forces of acceleration help make steering easier, the control valve reduces the flow of hydraulic fluid.

The control valve might be sticking, and it may be possible to free it by revving the engine with the car at

standstill a few times. This builds up hydraulic pressure and loads up the control valve, which may free it. If it doesn't, replace the control valve.

7. At this point, troubleshooting a power steering problem involves making pressure tests with a power steering pressure gauge. Higher than specified pressure points to a restriction in the system. Lower than specified readings indicate a bad pump or an internal leak.

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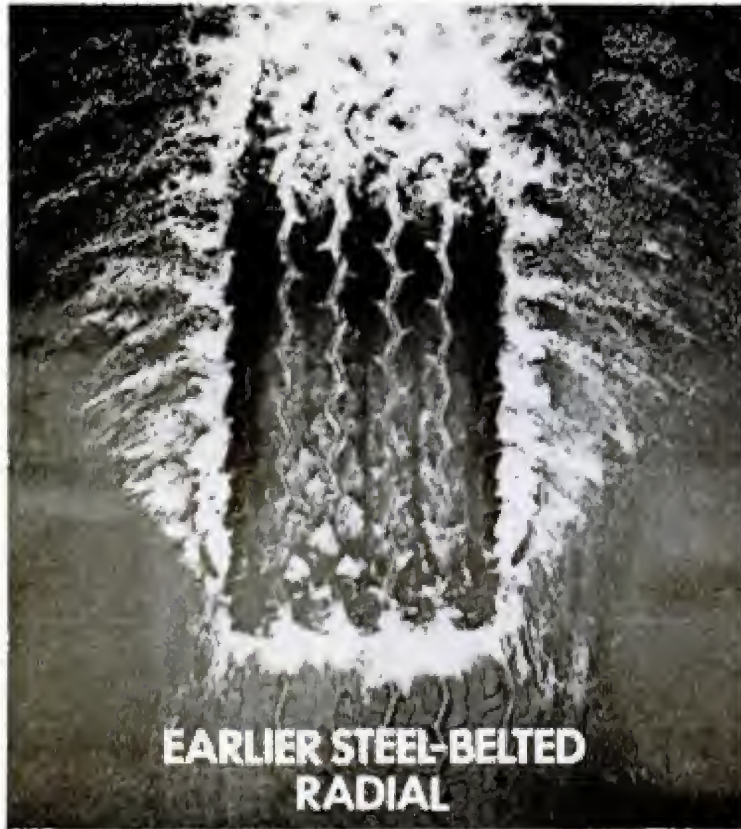
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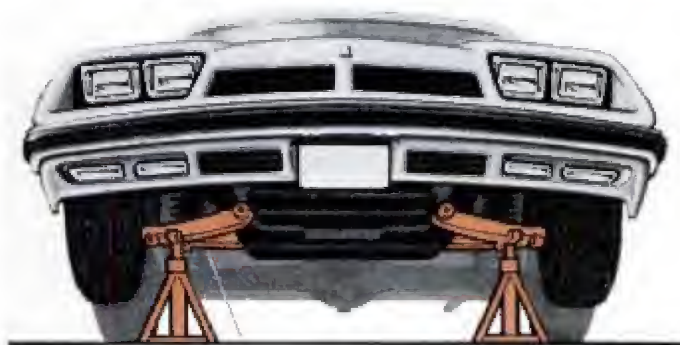
CAR CARE GUIDE

Four small footprints are all that keep your car in contact with the road; through them the car does your bidding. Proper care and inflation of your tires is a significant part of good gas mileage and handling, and, along with your brakes, the most important part of your car—the part on which you bet your life every time you roll out the driveway. Keep them clean, keep them inflated, but don't keep them when worn or damaged!

5. WHEELS AND TIRES: HOW THEY ROLL

RAISING THE CAR

USING JACK STANDS TO HOLD UP FRONT END



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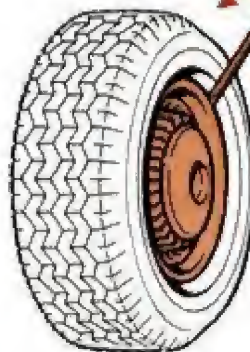
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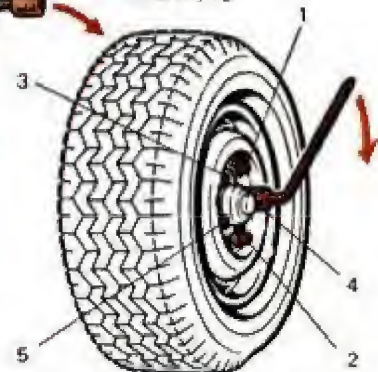
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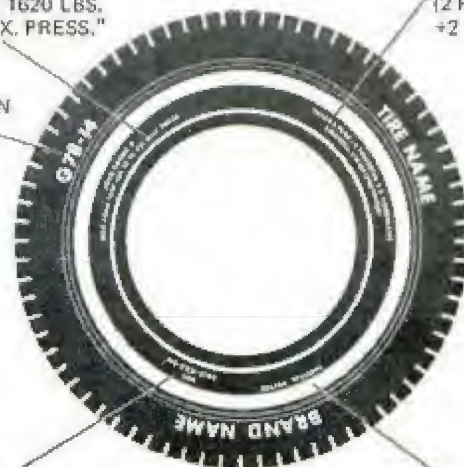
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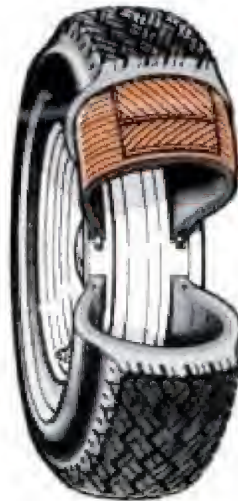
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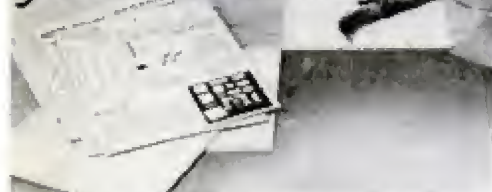
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CAR CARE GUIDE

5. WHEELS HOW TO KEEP

The one condition which ruins good tires more frequently than any other is neglect.

By neglect we mean riding on underinflated tires causing unnecessary and rapid deterioration. And more's the pity since all that's needed to keep proper inflation is an inspection once a month and air. Both are free.

Underinflated tires exhibit more wear on both outside treads than in the center. Overinflated tires, which wear out as quickly as underinflated tires, show more wear in the center tread than on the outside.

Check tire pressure using your own tire gauge.

Check tire pressure with tires cold, because hot tires assume more air pressure. If you bleed off pressure, you will actually have underinflated tires. A "cold" tire is one that has not been run for at least three hours.

Radial-ply tires, even when inflated normally, will show a "bulge" in the sidewalls at the bottom. This is normal, and you should not attempt to eliminate it. You will seriously overinflate your tires.

But many drivers who are used to seeing this bulge and know it's normal are lulled into a sense of complacency about checking tire pressure. The bulge of an underinflated radial tire looks almost the same as that of a properly inflated radial.

What is normal tire pressure?

Normal pressure for your tires is the one spelled out in your owner's manual and on the tire-inflation label which is placed in most vehicles. In many cases, this label is glued to the inside of the glove compartment door.

There are very few times when you should deviate from this pressure. One time is when you are going to make an extended trip at highway speeds. Another time is when you tow a trailer or pack in a full load of passengers and luggage. Then you may want to increase tire pressure.

By how much? Your manufacturer tells you, but if you can't find his recommendation, then inflate tires four pounds, but make sure you don't exceed the maximum inflation rating printed on the sidewall of the tire.

The story behind rotation

Front tires get more wear on their outer shoulders than in the center

5. WHEELS AND TIRES

AND TIRES: THEM ROLLING

because of turning and cornering. Rear tires (except in front-drive vehicles) experience more normal wear in the center because of the rear axle's power thrust.

The importance of rotation is that it equalizes wear so no one section of a tire will wear away faster than another section.

Bias and bias-belted tires are rotated in crisscross style. Radial tires are rotated from front to rear. Include the spare tire in your rotation pattern.

Some points about snow tires

If your car is equipped with radial tires having conventional tread, you must use radial snow tires. Mixing radials with any other kind of tire—bias or bias-belted—will affect handling adversely.

Keeping snow tires on their own wheels is a good idea. You don't have to break them from the rims every year—



Tire rotation equalizes wear and lengthens tire life. Radial tires are rotated front/rear and other types are crisscrossed.

which is rough on the rims and the tires. Studded snow tires should be marked left or right and mounted on the same wheel year after year.

Why you should be tire conscious

Get into the habit of examining tires periodically. Tread can tell you an important story, and inspection lets you find and possibly repair damage that can eventually ruin a tire needlessly and create a safety hazard.

Look for tread that's excessively worn. Tires have built-in wear indicators, which are solid bands that form across the tread surface when tires are worn and should be replaced. When tread indicators are evident across two or more adjacent ribs, replace the tire.

A simple examination of tread can also tip you off to a problem that's ruining your tires. For example, if two or more adjacent grooves show more wear than the remainder of the tread,

and recommended inflation has been observed, there is a malfunction in the suspension, steering or braking system, or front-end alignment is not correct.

When examining tires, also look for cuts in the tread or sidewall. Don't let the size of the cut fool you. Many times small cuts are more serious than large ones. Deepness is the important factor, so carefully probe the cut with a small screwdriver. If the tip reaches the cord, replace the tire.

Also look for bulges or bumps in the sidewall or tread. This indicates that the tread or sidewall has separated from the tire body and there is danger of a blowout.

Conclude your tire inspection by removing small stones wedged in the tread. Carefully pry them out with a screwdriver.

Some important facts about wheel balance

You have no doubt heard that whenever tires are mounted, wheels should be balanced. What does this mean?

The term "wheel balance" is a misnomer. A wheel can be in perfect balance, but if the tire or brake-drum or disc is out of balance, the wheel will be thrown out of balance. Wheel balance, therefore, applies to the entire setup.

If a wheel assembly is not in balance, vibration and tire wear may result. A wheel and tire should be balanced as a unit when you mount the tire on the wheel or replace the tire or wheel with a new one.

The brake drum or disc, tire and wheel should be balanced as a unit when you replace the drum or disc.

A wheel assembly can be out of balance in one of two ways: statically or dynamically.

If a wheel assembly is out of balance statically, a heavy spot exists at a single point. As the assembly rotates, the heavy spot is forced against the road with each revolution of the wheel, which leads to a pronounced vertical vibration.

If a wheel assembly is out of balance dynamically, heavy spots exist on opposite sides forcing the assembly to move from side to side and causing a horizontal vibration. The wheel oscillates, and the tire is scuffed against the pavement. One indication of a dynamic condition, then, is flat spots over the tire.

PARTICULAR ABOUT TIRES?

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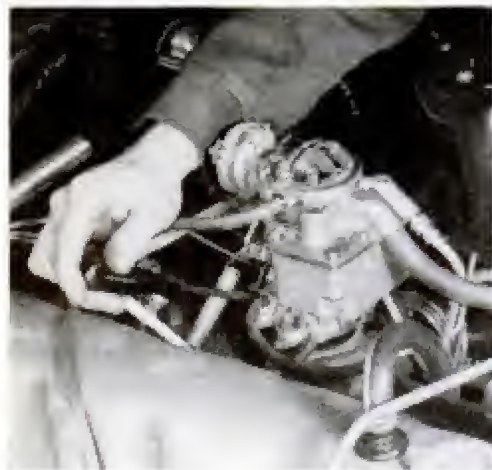
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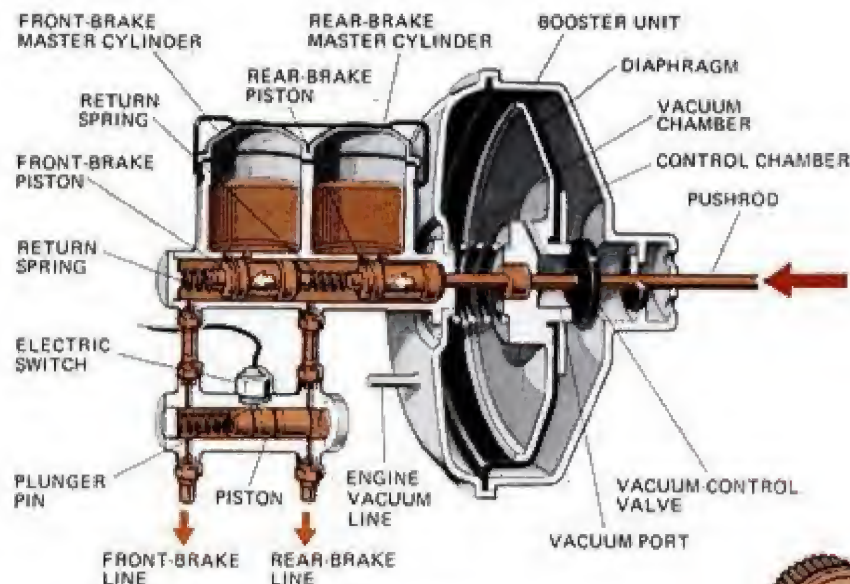
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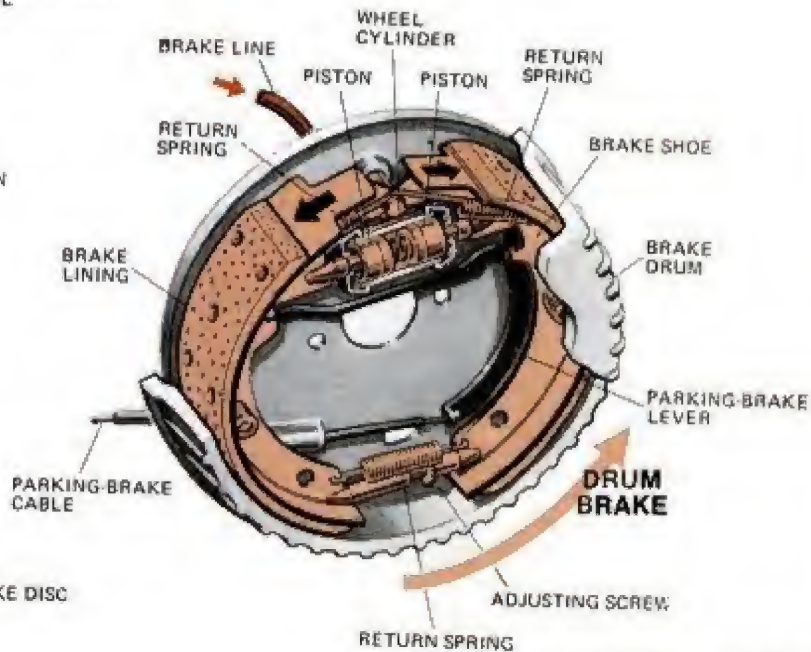
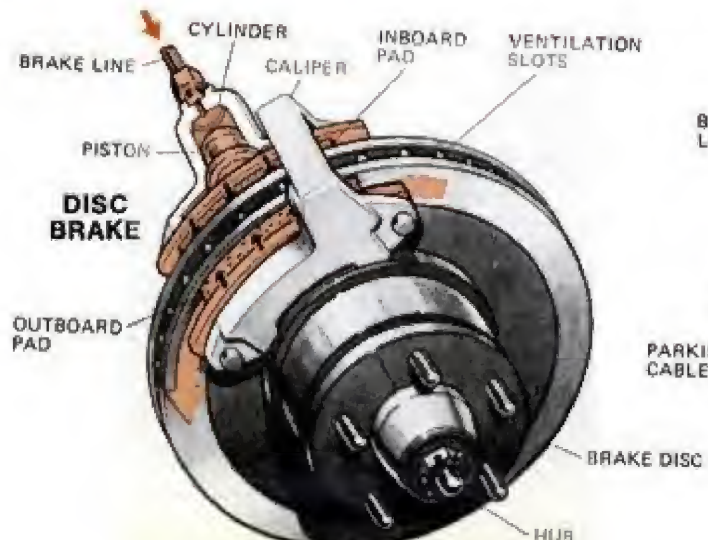
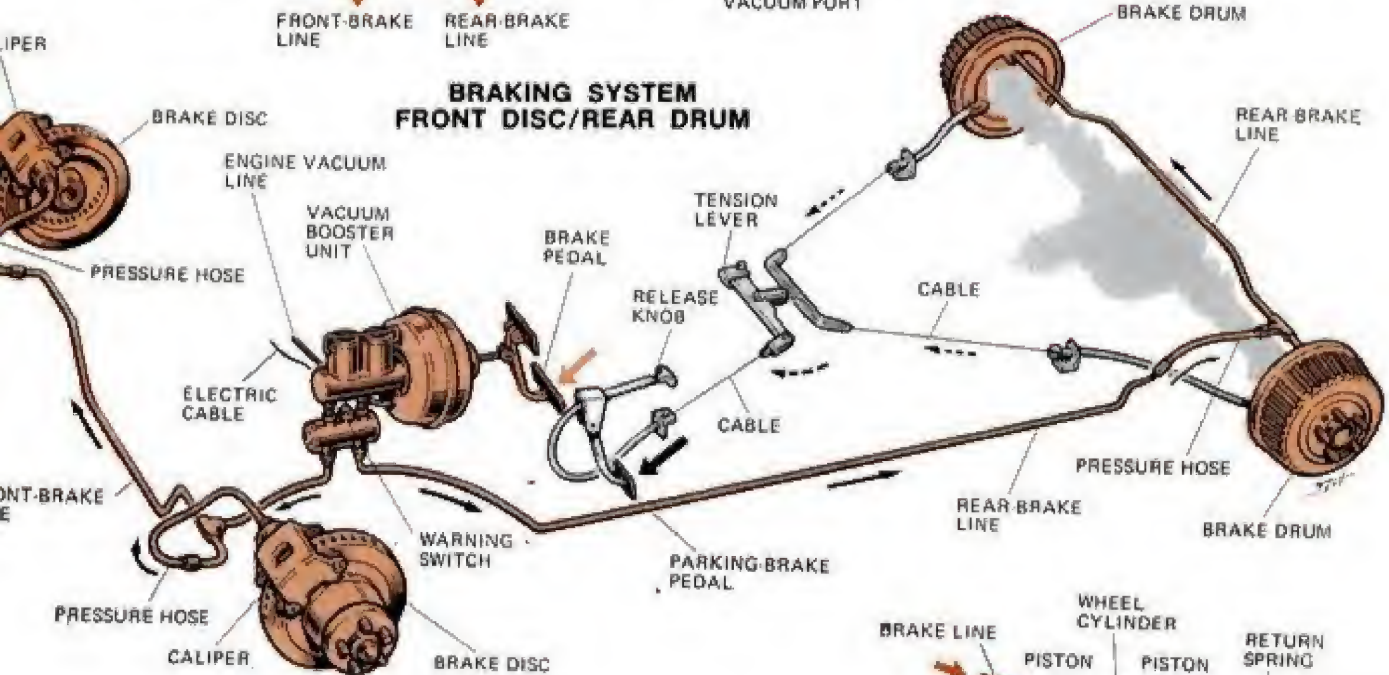
6. BRAKING SYSTEM: HOW IT WORKS

POWER BRAKE



Placing your foot on the brake pedal creates a pressure in the hydraulic system which applies the brakes at all four wheels. Just a touch is enough to push brake linings against drums or pads against discs. Even less force is needed when a vacuum assist is used in a power-brake system. Most recent refinements over the basic system include dual diagonal hydraulic circuits and electronic antiskid systems.

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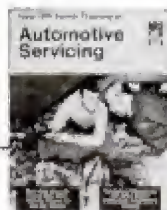
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CAR CARE GUIDE

6. BRAKING HOW TO KEEP

Your braking system should be tested and inspected every 10,000 miles to find a malfunction before it becomes serious enough to jeopardize safety, and more expensive to repair. Inspection is made with the car at a standstill, followed by a road test.

In-the-driveway brake tests

If your car's braking system is equipped with a power booster, start the engine and allow it to idle. If the car doesn't have power brakes, do not run the engine.

Apply heavy foot pressure on the brake pedal. It should feel firm. It should not feel springy or spongy. If it does, remove the master cylinder cover and see if there is a vent hole in the cover. Make certain that it's not clogged.

Test brake pedal firmness again. If sponginess or springiness prevails, the trouble is unquestionably trapped air in the hydraulic system.

Your braking system consists of two major areas. The hydraulic section includes parts such as brake lines and cylinders that hold and transport hydraulic brake fluid to the second major area, which includes brake shoes (or discs) and drums (or rotors) that do the actual braking.

Air can get trapped in a brake's hydraulic section when fluid is lost and has to be replenished, or when a brake system part is disconnected and reconnected. This is why it's important for brakes to be bled when work is done on the system.



Check brake fluid level in master cylinder.

SYSTEM: IT WORKING

Bleeding a brake system is not a difficult task, and it's one you should be familiar with. Each wheel is equipped with a bleed screw. The method is as follows:

1. If you have power brakes in the car, depress and release the brake pedal several times with the engine turned off to evacuate vacuum.
2. Remove the master cylinder cover. Fill the reservoir with fresh brake fluid of the type and quality recommended by the manufacturer of your car. Correct fluid level is 1/2-inch below the top of the cylinder.
3. Attach a length of clean vacuum hose that's about 18 inches long to the bleed screw of one of the wheels. Place the other end of the hose in a glass or clear plastic container which



Vacuum hose is slipped over bleed screw at one of the wheels for bleeding system.

is half-filled with clean, fresh hydraulic brake fluid.

4. Have an assistant in the car apply firm, steady pressure (no pumping) to the pedal. Open the bleed screw about 3/4 of a turn. When fluid in the container no longer bubbles, close the bleed screw.

The person in the car must maintain pressure on the brake pedal during the entire procedure. If he releases the pedal while the bleed screw is open, air will be introduced into the hydraulic system.

5. Close the bleed screw, and turn your attention to the next wheel. All four wheels must be bled.

6. After brakes are bled, discard the brake fluid in the container. Do

not use it in the braking system. It may be contaminated. Recheck the fluid level in the master cylinder, adding fluid if necessary.

Now retest the brake for sponginess. If the problem still prevails, a weakened rubber brake hose may be expanding under pressure.

Trace each brake line back off the master cylinder as someone in the car applies pedal pressure. Feel every rubber hose. When you find the spot in the troublesome hose which is weak, replace the hose.

How to adjust brakes

Notice brake pedal reserve. If the pedal is too low, brakes should be adjusted.

"Too low" is generally considered to be a pedal that doesn't "catch" until it's below the height of the accelerator pedal. However, brake height is a matter of preference.

Your car is undoubtedly equipped with a self-adjusting brake mechanism unless it dates back to pre-1960. The main cause of a low brake pedal is the failure by drivers to activate the self-adjusting mechanism as often as they should.

To adjust brakes, drive forward several feet, come to a *complete* halt, drive several feet to the rear and come to another complete halt. Do this several times.

The brake pedal should come up. If the pedal remains low, brake linings are probably worn, but there is a chance that the self-adjusting mechanism has frozen because of too little use. In any event, the brake system should be disassembled.

How to test for hydraulic fluid leaks

Note: If your car has power brakes, start the engine and let it idle. If the car has conventional brakes, leave the engine off.

Hold your foot lightly on the brake pedal for 15 seconds. The pedal should not move.

Hold your foot on the pedal, but this time with heavy pressure. The pedal should not sink.

If the system fails the pedal test, and you experience sinking, there is a leak somewhere. Your task is to find it. Here's how:

1. Inspect the master cylinder, looking for traces of brake fluid around connections. Perhaps a fitting is loose, so tighten them all.

2. As someone in the car pushes down on the brake pedal, examine all brake lines. If a line connection is leaking, tighten it, but if the leak persists, you should replace the line. Naturally, if a brake line has ruptured, it has to be replaced.



Check hydraulic system fittings for tightness.

3. Wheel cylinders of drum brake systems frequently begin leaking, which lets brake fluid run on mechanical parts. This causes grab and pulling to one side when brakes are applied.

If you haven't found a leak till now, inspect the cylinder in each wheel. The wheel has to be removed. If the



Check pressure hoses for damage, tightness.

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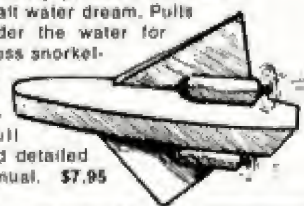
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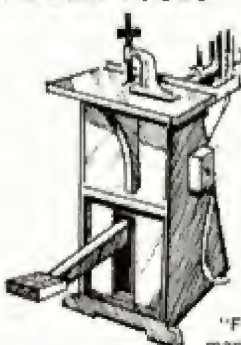


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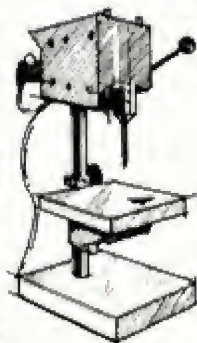


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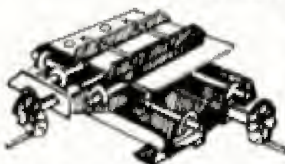
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"For pure pride of accomplishment, few things match the feeling you get when using a good tool that you built yourself." Dick Cutler should know. He designed this gem of a tool which you can build for about \$70. All parts are obtainable from hardware and hobby shops. \$6.95



PL-1402 Milling Table

An ideal machine for model builders, electronic hobbyists and camera buffs. Built entirely of parts found in hardware, hobby and plumbing supply stores, this precision tool costs about \$30 to build from scratch. Another Cutler design. \$6.95



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PL-1301 The Southern

Stick up a shed and neighbors may hate you. But build this cute storage building and they'll love you. So will your kids since this structure doubles as a playhouse. Platform and slide pond option in plans. Designed by Carl Sigman, Dean of backyard storage structures. 2 sets of plans. \$5.49



PL-1300 The Storybook

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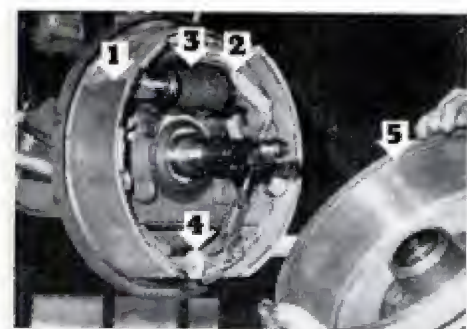
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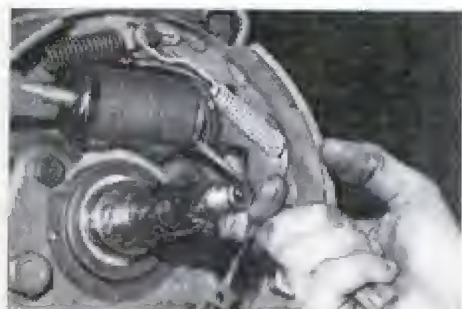
6. BRAKING SYSTEM



Parts of drum brake are 1. brake shoes; 2. return springs; 3. wheel cylinders; 4. self-adjust mechanism and 5. drum.

cylinder is equipped with rubber boots, as most of them are, pull back both boots. If fluid leaks out, the cylinder is bad and should be replaced.

If the cylinder is equipped with metal end caps, the brake lines coming



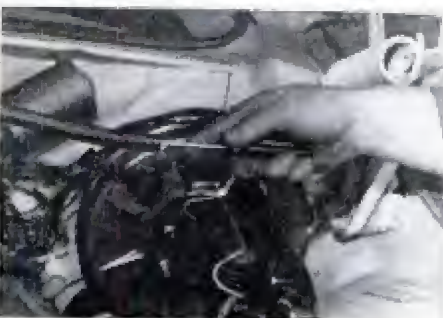
Check wheel cylinders for damage or leaks.

into the caps have to be disconnected and the end caps removed so you can look for a leak.

The cylinder of a disc brake may also leak and should be examined. This is outlined below where we describe how to check the thickness of pads.

4. If no damage has been uncovered to this point, then the reason for a falling pedal is probably damage inside the master cylinder. An odor of brake fluid in the car or beneath the hood confirms this.

If the car has a power brake, you can check for a fluid leak in the master cylinder by removing the vacuum hose from the brake booster and twirling the shank of a screwdriver



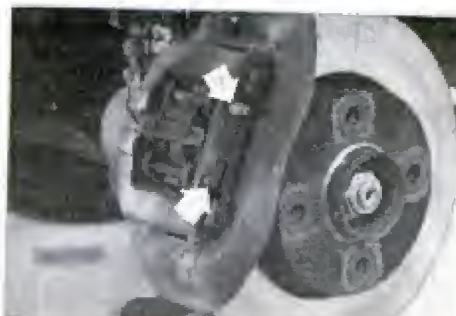
Vacuum hose will show signs of brake fluid if fluid is leaking through master cylinder and being sucked into hose by engine vacuum.

inside the hose. The presence of fluid on the screwdriver confirms the damage. Replace a damaged master cylinder.

How to inspect brake linings

If the car has drum brakes on all four wheels, remove one of the front wheels to examine linings. If the car has drum brakes on the rear and disc brakes up front, remove a rear wheel.

With a scale, measure brake lining thickness at several places. Replace



Guide pins are removed for access to pads.

shoes if thickness is 1/32 inch or less at a point.

If you replace shoes on one wheel, replace shoes on the other wheel of the same axle. Failure to do this will result in unequal brake action.

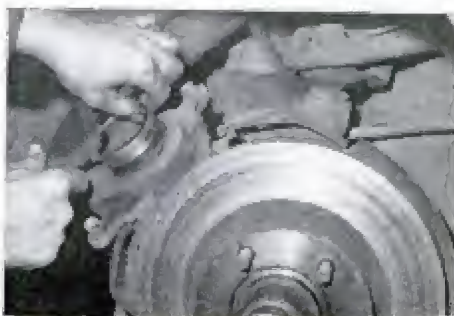
To check the thickness of disc-brake pads, remove the pads from a caliper. Only one wheel has to be checked.

Pads are usually held in place by guide pins which are secured with hanger-shaped locking clips. Remove the clips and any damper spring, if used. Pull the guide pins out, leaving pads free.

Slide both pads from the caliper. If you can't get a firm grip, grasp the pad with a pair of locking pliers and pull.

When both pads are removed, examine the exposed rubber boot surrounding the piston bore. If there is hydraulic fluid present, the caliper should be overhauled.

Measure pad thickness, which should



Brake fluid found on any external parts indicates a leak in the system.

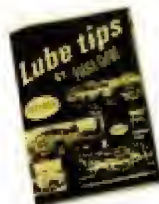
be more than 1/16 inch. Replace pads of this wheel and the ones of the other wheel on the same axle if pad thickness is too thin. ★ ★ ★



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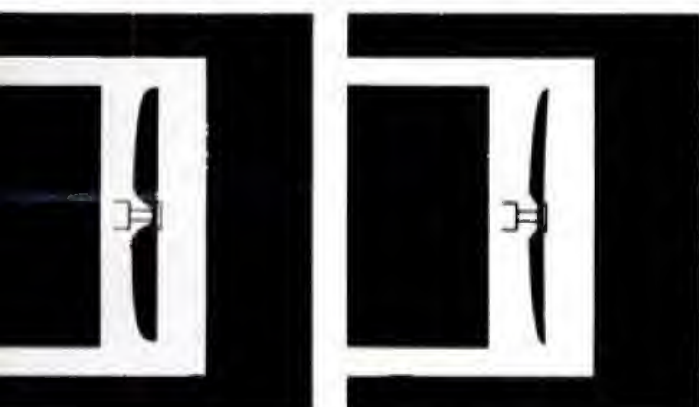


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A lot of people buy Flex-a-lite® engine fans because of over-heating problems. Because they've added air conditioning or are towing a trailer and need more efficient engine cooling.

But, let's say everything's cool with your car the way it is. Why change status quo? Glad you asked.

Less weight, less engine drag.



The Flex-a-lite fan weighs a fraction of what's on your engine now. And, as RPM increases, the Flex-a-lite blades flatten out to further reduce drag. Result: improved performance, more horsepower to the wheels.

Improved mileage.

All things being equal, a Flex-a-lite fan will give you extra miles to every tankful of gas. And, these savings that's pretty important. Reason why? Re-read item 1 above.

Cuts repair bills.

Less strain on fan belts and water pumps means longer life, less maintenance. Plus, the Flex-a-lite fan eliminates that troublesome fan clutch.



Here's what Flex-a-lite customers tell us:

"For two years I have pulled a 22-foot Airstream with a Ford Fairlane and your Flex-a-lite fan. It did not overheat on the 10,000-foot passes, nor in Phoenix, Arizona, in 115 degree weather."

O. W., Arizona

"It dropped the running temperature of the engine about 7 degrees and really keeps the header cool. It is the best."

G. H., Florida

"This is the fourth car I've put a Flex-a-lite fan on. It has made them all run quieter, smoother and gives more pep and better acceleration."

R. M., Washington

"Durability tests were run on 70 installations for over a year and approximately 9,450,000 miles before we changed all fans on our trucks to Flex-a-lite."

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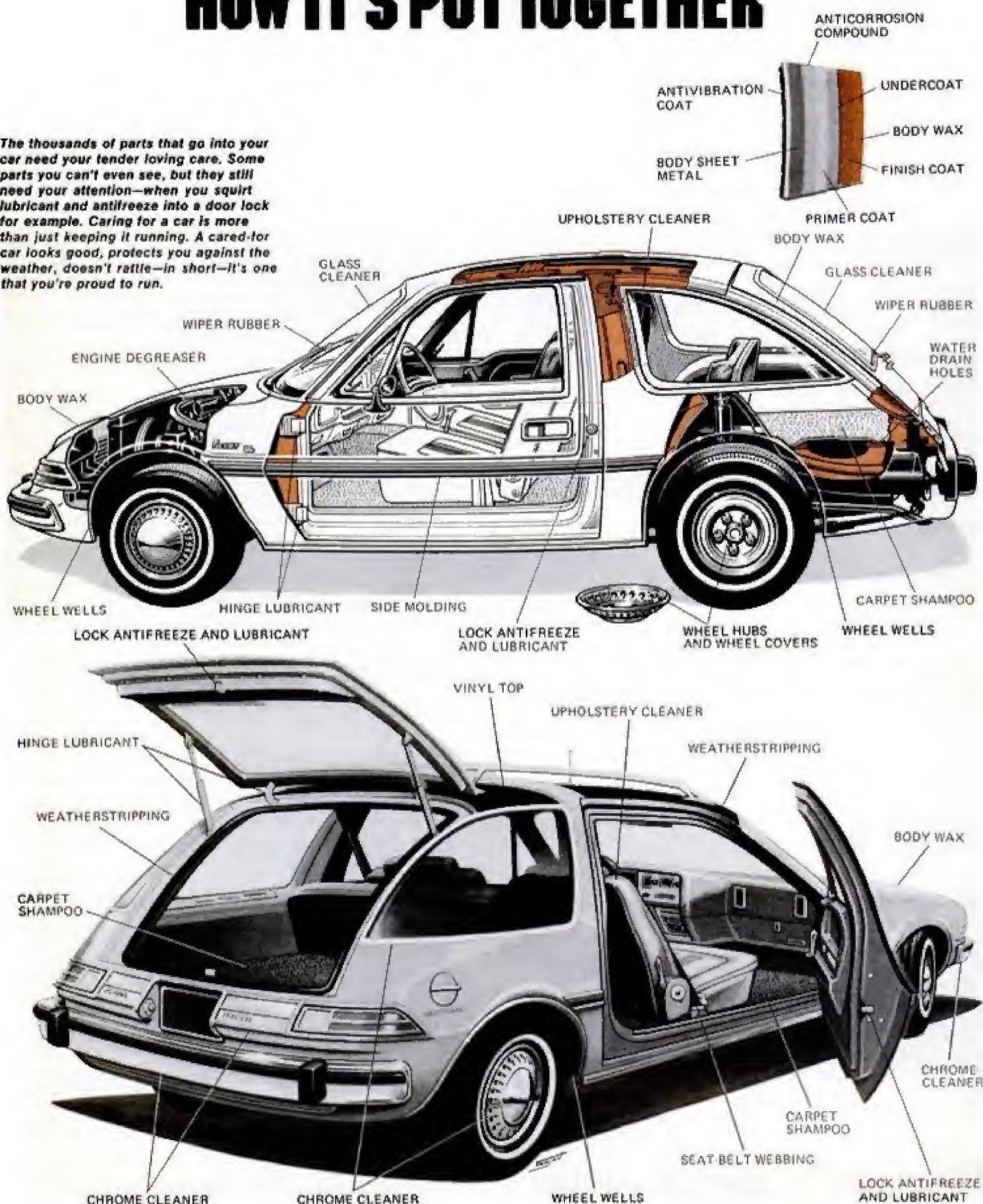


Flex-a-lite Corporation

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7. YOUR CAR'S BODY: HOW IT'S PUT TOGETHER

The thousands of parts that go into your car need your tender loving care. Some parts you can't even see, but they still need your attention—when you squirt lubricant and antifreeze into a door lock for example. Caring for a car is more than just keeping it running. A cared-for car looks good, protects you against the weather, doesn't rattle—in short—it's one that you're proud to run.



7. YOUR CAR'S BODY: HOW TO CARE FOR IT

When it comes to your car, beauty should be more than skin deep, because there are several environmental conditions that can cause rust and eat away at the finish. They include road salt, industrial pollution, mud and salt air.

One step you can take to protect your car against the rusting which road salt and mud can cause is to wash the underside of the vehicle with a high-pressure stream of water from a hose.

Pay attention to such areas as the underside of the engine block, transmission, driveshaft, differential, exhaust-system parts, plus frame and suspension.

Give fender wells and undersides of bumpers extra treatment. Mud and other contamination get trapped here and can be a bed from which rust grows.

The right way to wash a car

The best way to safeguard a car's finish is to wash it often. Washing gets rid of surface dirt before chemicals in the dirt can eat into the finish.

Wash the car parked out of the sun so metal remains cool. Hot metal will cause the finish to streak.

Here are several important tips regarding washing to be observed:

1. Use a mild liquid soap or a commercial car-wash you can buy in an auto parts and accessories store. Never use strong or caustic detergents.

2. Use your hose to play a high-pressure stream of water along edges of metal trim molding. This will force out dirt trapped underneath.

3. Wash off dust with cold water



Wash car with compounds made especially for the surface. Don't use strong detergents.

before applying a car-wash solution.

4. Wash one section of a car at a time—such as roof, hood, trunk lid or fender. Work down from the top so runoff doesn't flow over clean areas.

5. Apply cleaning agent with a soft,

clean cloth, sponge or car-wash mitten. When a section has been treated with the cleaning agent, rinse it at once with fresh water from your hose.

The danger of treating more than one section at a time with cleaning agent lies in having it dry before it can be washed away. This will cause streaking.

6. Difficult spots to clean, such as those spattered with tar, bird droppings and the like, should be softened before they can be washed off. Don't rub them because you could damage paint. It's best to treat these spots with a commercially available tar and spot remover.

7. When the entire body of the car has been washed and is clean, give it a thorough rinsing and then dry it



Special cleaners are made for removing tar.

immediately with soft cloths to avoid streaking. The best drying "cloth" to use is a chamois.

To polish a car

Cleaner/polish removes particles of "dead" paint and brings out the luster of freshly exposed paint underneath. Wax lays a protective coating over the finish so its brilliance is maintained, and the paint is protected from agents that can damage it.

Cleaning and waxing compounds are available in several forms: liquid, presoftened paste and spray. Select the one you want, but be sure you follow the manufacturer's instructions.

Generally, before you polish the car, its surface should be washed and allowed to dry thoroughly. Use a clean, soft cloth as a polish applicator.

Polish one section at a time. Use a circular motion to apply the product, overlapping that part which was just polished. Apply pressure on the applicator as you rub so that oxidized particles will be removed.

When the polish dries and is ready to be removed, it will look hazy. Remove the coating with a clean, soft rag. When the polishing rag gets



Cleaners, polishes remove oxidized paint, restoring a dulled finish to high luster.

coated with a hard glaze, change it.

If you apply wax separately, first soak a clean cloth in water and wring it out. Apply the wax to the cloth, and then to the finish.

Rub the wax over the car's body with vigor, using a circular, overlapping motion. Do one small section at a time, letting the wax dry thoroughly. When dry, remove it with a clean, soft cloth.

Finally, to bring out the luster, buff the finish. You may use a buffing wheel, but do not apply pressure.

If your car has a vinyl top, the secret to keeping it looking good is to clean it often. Once dirt takes hold, restoration becomes more difficult.

Clean a vinyl top by first washing off dirt while scrubbing with a soft-bristle brush. Never use a wire brush. You'll rip the top right off the roof.

There are several good vinyl top cleaning agents sold at auto parts and accessory dealers. Follow instructions. You will also find available agents that match the color of the top, or are neutral in tone, which bring out the vinyl's luster.

Another job you may do to make your car sharp-looking is to clean its white-wall tires. Use only a commercial tire-cleaning agent made for the purpose, which you will find in auto parts and accessory stores.

Usually, a simple dusting and vacuuming are all that is needed for the car's interior. If upholstery is dull, however, mix a sudsy, warm-water solution using a household liquid detergent. Apply suds to upholstery with cheesecloth pads or terry cloth, rubbing gently. Rinse by wiping the upholstery with clear water.

Finally, clean and wax all those places usually neglected: door jambs, painted metal under the hood. Degrease the drive train. Use old toothbrushes and even cotton swabs to reach tight areas. Remember, tender loving care pays off!

★ ★ ★

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CAR CARE GUIDE

TRAVEL SAFE

There are two kinds of emergencies you can have on the road. Both are related, because one usually leads to the other. One involves your safety, while the other involves your car's mechanical condition.

When your car "goes dead" for whatever reason—flat tire, electric or fuel-system failure, a passenger getting sick—a safety hazard is created by the simple act of your pulling off the road and having to park. This hazard is increased if it occurs at night.

Caution: If at all possible, always pull off onto the right-hand shoulder of the road. Stopping along the left-hand side only contributes significantly to the danger.

Onrushing vehicles, especially on high-speed highways, are not always on the lookout for disabled cars. Many drivers and their passengers have been killed or seriously injured in roadside accidents, because they weren't seen or were seen too late.

The obvious way to avert tragedy is to warn oncoming cars that a hazard exists, and to do it as far from the actual scene as possible.

Hazard flashing lights that manufacturers have placed on cars in recent years are good for safety, but even more effective are other warning devices. One is flares. You have probably seen them. They are used by highway patrolmen and truck drivers to warn of impending danger. To get flares working, pull a "trigger" and set them on a small stand along the road.

Of flares and warning signs

Flares are excellent devices if positioned properly. If you have a breakdown, place flares far enough away from your car so they provide sufficient warning. As a rule of thumb, flares should be placed about 150 yards from the disabled vehicle.

There is another point to consider regarding flare placement. If you get stuck right around a curve so you are in a "blind spot" as far as oncoming traffic is concerned (traffic coming from either the rear or the front), place flares ahead of the curve so drivers will realize that danger exists on the other side of the curve. There is nothing more dangerous (or more stupid) than putting a flare right near a disabled car to give a guy coming around a curve the surprise of his life when he's on top of trouble.

Other types of warning devices are large trunk signs bearing highly reflective letters which read something to the effect: "SLOW . . . DISABLED." Reflective triangles, positioned as you

would flares, are in use, too.

The trunk sign is usually set up between the trunk lid, which is open, and the base of the trunk. The lid bearing down on the sign holds it in position.

A sign of this sort can usually be seen over 500 feet away, assuming of course that visibility is good. In fog? Well, that's another matter.

The sign has certain limitations. For one, you should have two if you become disabled on a two-lane road and want to give drivers full warning. One sign should be pointing to the rear, and the other should be pointing front.

If you get stuck on a curve, the signs would have to be set up ahead of the curve to warn motorists who can't see around the curve. This means you would have to devise some sort of easel to set the sign along the road.

An emergency toolkit

Many different mechanical problems can afflict a car on the road. Some we mentioned above. Others include not being able to get restarted because of a weak battery, a broken drive belt, a radiator hose bursting, a fuel pump breaking down, losing your keys after making a rest stop, blowing a fuse in any one of a number of systems, and so forth and so on.

Listed below are many parts and tools that you might want to consider carrying in your car for emergencies. Remember, when a breakdown occurs, you apply an emergency procedure—that is, in most cases, a temporary fix—to get you to a service area for permanent repairs. ★ ★ ★

EMERGENCY TOOLKIT

Bar of soap (for smearing over small leaks in a radiator to seal them).	can of ice-melting material.
Block of wood for base of jack on soft ground.	Ignition key.
Booster battery and/or jumper cables.	Ignition wrenches.
Brake fluid.	Jack.
Bulbs (especially spare taillight and signal light).	Knife (sharp).
Cloths.	Lug wrench.
Distributor cap.	Penetrating oil.
Distributor points, condenser, rotor.	Radiator hoses and clamps.
Drive belt.	Sandpaper (or battery-terminal cleaning tool).
Electrician's tape.	Screwdrivers.
Fire extinguisher.	Shovel.
First-aid kit.	Solderless connectors.
Flashlight.	Sparkplugs and sparkplug wrench.
Fuel filter.	Tire gauge.
Fuel pump.	Tire pump.
Funnel.	Towing chain or rope.
Fuses.	Water.
Gas can.	Wheel chocks.
Ice scraper or spray	Wire.
	Wrenches (various types and sizes).

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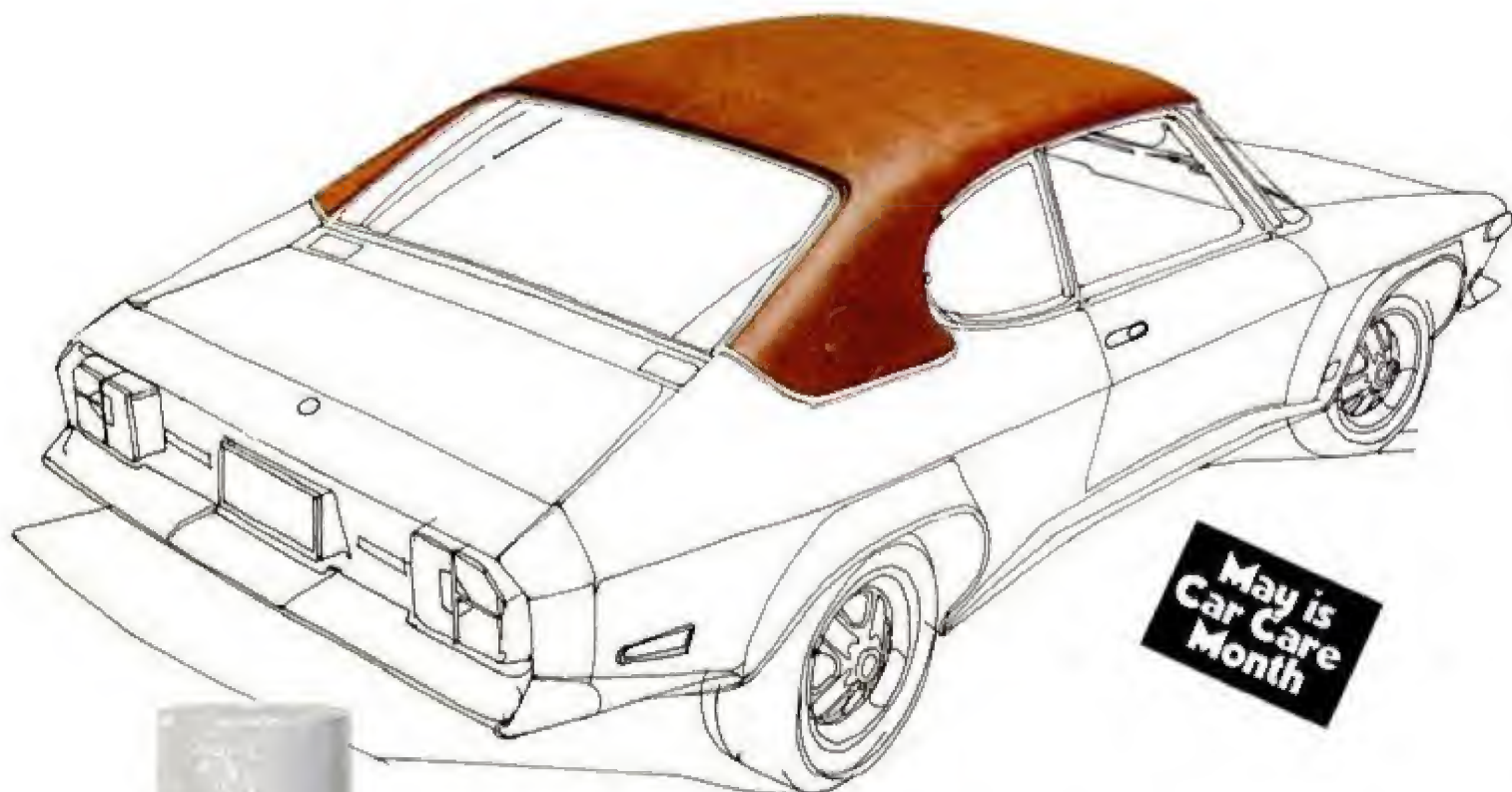
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Consumer Products Division

About moldings

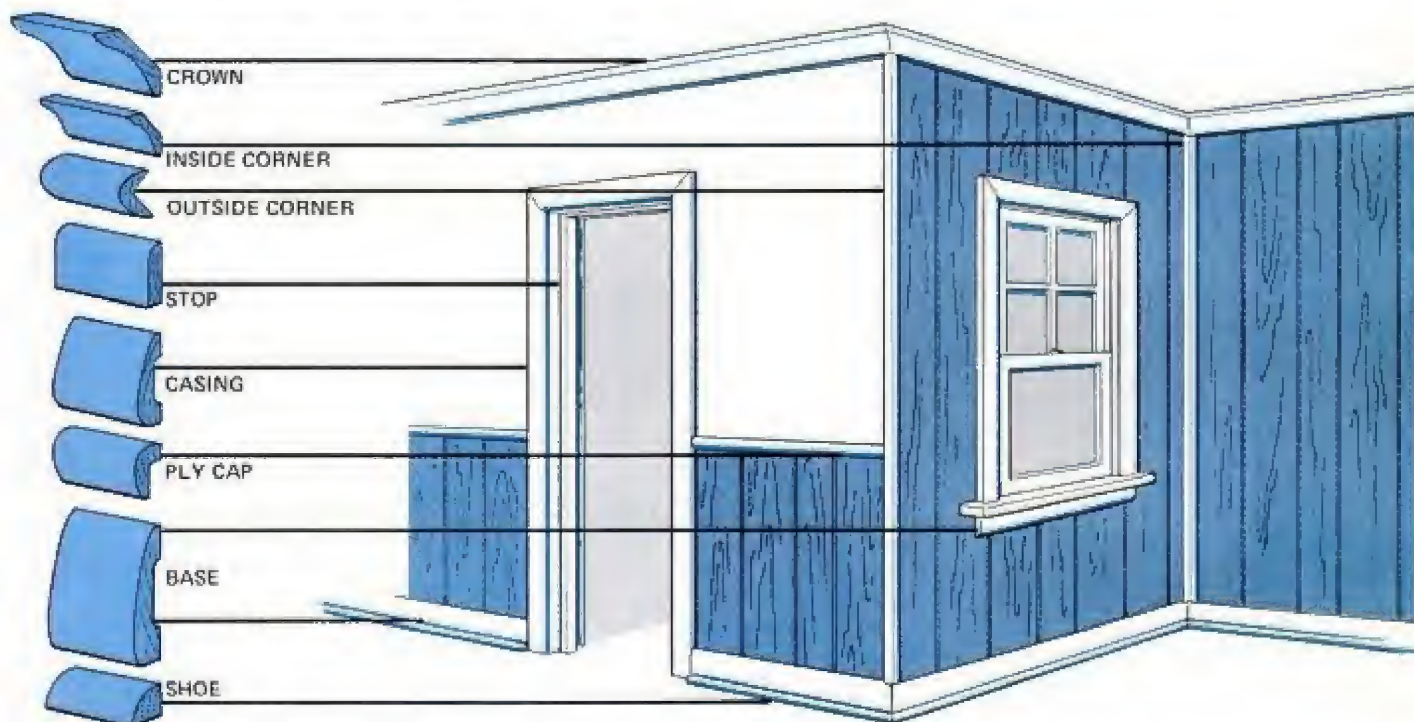


Moldings are installed after all paneling is up. For accuracy and neat-looking job, use miterbox to make all molding cuts.



Insurance against opened miter joints—apply white glue to joint and keep it closed for good with a 4d finishing nail.

Pick the right molding for the job



Prefinished moldings are offered by most paneling makers to match panel finishes. To keep down costs, you can consider using pine moldings and staining or painting to match. If you

HOW TO WORK WITH PLYWOOD PANELING

(Continued from page 93)

the cut, *leaving the line*. Finish by dressing the edge exactly to the line with a sharp block plane or rasp plane.

Butt each succeeding panel tightly against the previously installed panel. (Except when installing hardboard; here you should leave a slight space at the joints. To avoid butting hardboards, tack a couple of thin nails next to the edge of each previously installed panel; pull tacks after the following panel is installed.)

Nails and adhesive

When you're nailing to studs, furring strips or sheathing, use either 3d finishing nails or 1-in. brads. Nails should be used every 6 in. along edges and 12 in. on intermediate furring. Generally, it is best to drive nails at a slight angle (toenail) through bevels and grooves. Set nailheads and hide them with a matching putty stick.

Adhesive speeds up the job because it cuts down on the number of nails needed. Don't apply adhesive to the wall until you're satisfied with the panel fit; then mark the panel edge on the wall so you will know the limit for adhesive application.

Squeeze on adhesive liberally and stand the panel in position. Drive in five or six nails *along the top edge*. Then, to permit adhesive solvent to escape (flash off), prop the panel open for six to eight minutes. Remove the block, return the panel to the wall and finish installing it with nails spaced 12 in. along edges, 24 in. in the center.

Cutouts

The easiest and most accurate method of making a cutout is that where a ruler and spirit level is used as shown on page 93. If you haven't used this stunt before, try a practice run with scrap. The trick here is to make sure that the panel is temporarily tacked in the *exact position* it will occupy when permanently installed so

Please turn to page 190

choose this course, temporarily install moldings for accurate fitting, remove moldings and mark the installation order on trim. Apply finish to trim; when it's dry, reinstall.



Model 120
Solid $\frac{3}{4}$ " Black Walnut
74" x 16 $\frac{3}{4}$ " x 10"



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- Breakfront swan neck and finial, waist and dial doors, dial frame and sculptured basefront pre-assembled.
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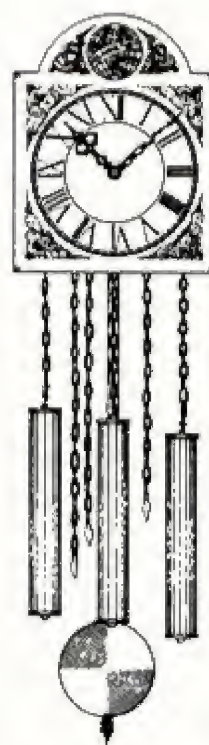
Emperor's 100-M grandfather clock movement is produced in West Germany, the proud work of famous clocksmiths who follow a hundred-year-old tradition of manufacturing the world's finest movements. When received at our plant, all Emperor movements are thoroughly inspected and tested in our quality control room by factory-trained clocksmiths. This insures lasting accuracy and dependability.

Embossed overlays surround the solid brass dial. The face has a high, permanent polish and serpentine hands. You can select from two dial versions. One has the words "Tempus Fugit" (Time Flies) inscribed in black enamel on a shaped world in the arch above the dial face. The other has the classic Moving Moon with a lunar calendar.

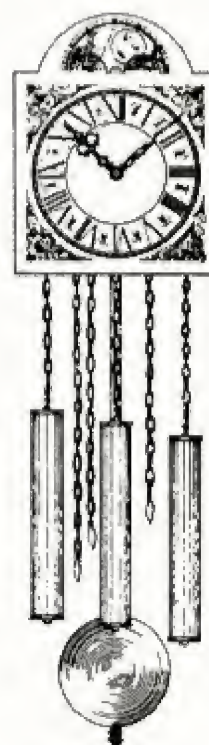
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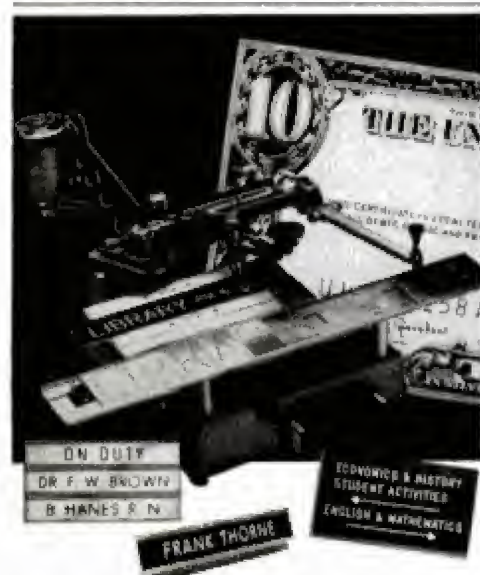
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HOW TO WORK WITH PLYWOOD PANELING

(Continued from page 187)

that marks transferred to its face are accurate.

After you mark the panel, place it on your worktable and punch holes with a finishing nail at the cutout's four corners. Flip the panel and connect the holes to mark the cutout on the back side. The easiest way to make the cutout is with a sabre saw. Lacking this tool, you can cut the panel face-side up using a keyhole saw after boring a starter hole with a $\frac{3}{4}$ -in. bit.

There are other methods of marking cutouts—transferring chalk or grease pencil as shown on page 93, for example. In my opinion, this method is inaccurate because the transferred mark is always wide. Too wide for accuracy. Which side of the line do you cut? Or do you cut down the middle? For best results, stick with the first-described method; you'll come out ahead.

Carpentry tricks

Worktable. Easy to set up, the worktable shown provides a rigid table for ripping, crosscutting or for making cutouts in paneling. You can make it of a height that's comfortable for you by altering sawhorse-leg lengths; generally, it is best to work over a table no higher than 26 to 28 in. from the floor.

Use at least three 2x3s across the sawhorses. When ripping, make certain a pair of these supports are beneath that portion of the paneling on which the circular saw is riding. The cutoff portion rests on a single 2x3 so it will fall away as the cut is completed and not bind the saw.

Cutting panels. You can use either hand or power saws, depending on your work preference. With either, cutting edges must be razor sharp for you to turn out a craftsmanlike job.

Some use the gimmick of putting masking tape along a line to be cut, believing this to be the only way to avoid splintering a plywood edge. But a sharp tool used properly guarantees the same results.

For hand cutting, use a sharp, crosscut saw with little or no set. Cut with the panel face up, and make certain you support the cutoff piece as each cut nears completion.

With a power saw, use either a plywood-veneer blade or hollow-ground combination blade (no set on either). Cut paneling this way:

- Table saw: Cut with face side up.
- Radial arm saw: Cut with panel face down.
- Portable circular saw: Cut with face down.

■ Sabre saw: Cut with face side down. Use a fine-tooth plywood blade, and use the shoe insert if one is provided by the saw's manufacturer.

Moldings. Though it's often tempting to rely on moldings to hide a multitude of sins—in this case that means a sloppy job—every effort should be made to cut and install paneling accurately so you can use the narrowest-possible moldings.

Prefinished moldings, though considerably more expensive than conventional pine moldings, have exacting contours and finishes that perfectly match the panels they are mated to.

Use a miterbox to make all molding cuts—both straight and angled. All inside joints should be coped with a coping saw—to assure a non-opening joint. To do this, first make the 45° cut in the miterbox; next, follow the molding profile with a coping saw. For the tightest fit, hold your coping saw at an angle so that the cut is made with a slight back cut—that is, the front edge should come to a feather edge.

All outside corners should be mitered. To prevent them from opening, apply white glue and install 4d finishing nails through the edges and into the mating molding.

Molding can be applied with appropriate-sized finishing nails or with construction adhesive and (fewer) nails. It's a matter of personal preference.

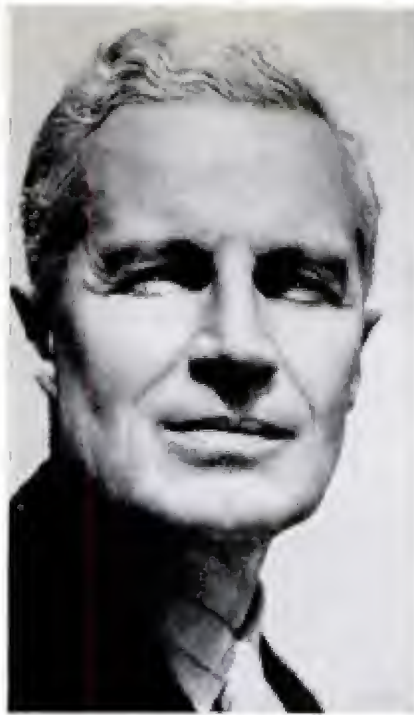
Moldings are available in a great number of sizes and shapes; you can choose what you need from charts or sample boards that your lumberyard dealer will have on display.

Finishing details. It is not necessary to set and fill every nail on every panel in the room. Professional carpenters locate those that must be set by shining a harsh light along the walls and watching for nailhead reflections from both sitting and standing positions. Nails easily spotted can then be punched in with a nailset and filled by rubbing with a putty stick colored to suit paneling.

To use filler sticks, rub them briskly across the indent to be filled; friction more or less melts the substance into the hole. You can then rub off the excess filler with a clean, soft rag.

If you cannot match your paneling with a single filler stick, mix several sticks until you obtain the perfect match.

If desired, you can complete the job by applying a high-quality furniture polish. One brand that excels is Guardsman. ★★★



I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be—today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my

summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish*! And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned*! I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to

gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and

ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest \$15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

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How to repair ceramic-tile walls



Using your fist or a rubber mallet, tap all over to locate and remove loose tiles. Tap gently to avoid cracking the tiles.



Completely remove old adhesive by scraping with putty knife; if necessary, use compatible solvent to soften mastic.



Remove large chunks of grout from tile edges by hand, then grind off any remainder with a coarse grinding wheel.



Apply ceramic-tile adhesive with a putty knife after making certain that the wall surface is thoroughly dry and sound.



Spread adhesive with a serrated trowel and carefully press tiles in place. Author also put some adhesive on tile backs.



Press acrylic grout into the joints with your fingers. Fill all cracks so grout is flush with the face of the wall.



Wipe entire area with a slightly dampened sponge. Don't over-wet sponge or the grout will be washed out of the joints.



Permit grout to dry for the time period recommended by maker. Then remove white film by polishing with a dry towel.

Loose tiles on a bathroom tub wall invite expensive-to-repair water damage to plasterboard behind tiles and to a ceiling below. Though time-consuming, tile repairs are inexpensive and very much within a do-it-yourselfer's skills. Remove the loose tiles, cleaning the wall surface and preparing it for re-application of the original tiles.

Grouting, a once-bothersome chore, is now greatly simplified: New acrylic latex grouts are easy to handle, but make certain you read the maker's instructions before using. After applying grout, let it dry thoroughly (overnight) before wiping tile with a dry turkish towel. To polish tile, use a quality glass cleaner such as Glass Wax.—Victor W. Kondra



Where did your last can of aerosol deodorant go?

Propellant makes up a large part of aerosol deodorants. Mennen Speed Stick® is a solid deodorant that applies evenly, exactly where you want it. So it lasts a lot longer.

Get off your can. Get on the stick.



GRAND OPENING FOR AN OLD CANAL (Continued from page 70)

such widely publicized operations as the raising of the giant *Normandie*, which burned at a New York pier during World War II.

The Suez was still being cleared of explosives when the first contingent of Murphy Pacific salvors arrived on May 27, 1974. The operation was headed by Capt. Joseph F. Madeo Jr., who had come from the Navy. A husky gray-haired man, he had commanded a harbor clearance unit in Vietnam before retiring in 1970. John Kjellman, his assistant, also was an ex-Navy man with Vietnam salvage experience.

Capt. Madeo headed a work force of 215 men at its peak: divers, riggers, explosives technicians and other specialists needed in salvage work. The general approach was to work several wrecks at the same time, moving men as needed. At the start, work was concentrated in the northern end of the canal.

The main lifting units used were two self-propelled cranes, each with a lifting capacity of 550 tons, and two Yard Heavy Lift Craft (YHLC). Using two YHLCs together, a maximum lift of 4000 tons can be made.

Typically, the two YHLCs are an-

chored on either side of a sunken ship or part of a ship. Sets of cables—as many as 17 pairs are available—are strung under the wreck. In some situations, the cables are “sawed” into position under the keel of a ship. This is done by winching the cables back and forth until they work their way along the hull to the correct position. If this technique is not feasible, divers use high-pressure water hoses to cut trenches under the hull. Messenger cables, attached to the main cables, are then pulled through the trenches.

Once the cables are firmly fastened beneath the bottom of a wrecked ship, the YHLCs take on ballast, lowering their hulls until the tops of their decks are within a few inches of the water level. With the cables taut, the ballast is pumped out, causing the YHLCs to rise in the water, lifting the wreck some six feet. Now the wreck can be moved under water, perhaps to a shallower site, where the procedure can be repeated and another six-foot lift accomplished.

In the Suez, many wrecks were cut into sections—with explosives and arc-oxygen cutting torches—and the sections lifted one at a time. Ulti-

mately, the sections were dumped at designated areas along the canal.

Only two of the 10 vessels had not been sunk by means of explosives—the tug *Barreh* and a 2000-ton dredge named *15 September*. The dredge, sunk by opening its seacocks, was refloated and delivered to the Suez Canal Authority, in charge of canal operations.

The final wreck was cleared on Dec. 19, 1974. It was a routine job, according to Capt. Madeo. But what may be routine to salvage men would resemble a real can of worms to the average landlubber.

Salvaging a big concrete caisson, for example, was no picnic. “We were doing some preliminary work on the caisson,” Capt. Madeo recalls, “and we had divers in the water when two antipersonnel ‘bomblets’ detonated. Fortunately, the divers were on the opposite side of the caisson and were not using Scuba. They were in hardhat gear—and didn’t feel anything more than a slight jar.

“Those divers really deserve a commendation. They never blinked an eye, but went right down again. Before we were through, we’d taken 19 bomblets out of there.”

Another tricky one was the tug *Barreh*. She had been loaded down with explosives and taken out to a “sink site.”

“She simply sank before they could blow her up,” says Capt. Madeo. “When we got to work on her, she was still loaded with explosives. We walked a little gingerly around that one.”

Explosives weren’t the only problem. The men were worked 12 hours a day, 7 days a week, with 2 days a month off for “R & R.” Some of the guys would make a beeline for Cairo, only to discover that women are kept on a pretty short leash in Moslem societies. More than one salvor returned to the canal complaining, “There just ain’t any broads.”

Step one, the cleanup of the canal, is pretty well completed now. Step two will be the restoring of the canal to its 1967 level of operations. That will entail the dredging of three feet of silt from the bottom and removing mountains of dry sand from the banks of the canal. The sand was used to make fortifications during the 1967 and 1973 Arab-Israeli wars.

As this is written, Egypt doesn’t seem in any hurry to get the canal into operation again. First, say the Egyptians, Israel has to pull back her troops in the Sinai. And since the Middle East continues to be as explosive as ever, one must wonder whether the future development of the Suez Canal will go according to present schedule. ★ ★ ★

(Continued from page 71)

the Coriolis force, named in honor of a nineteenth-century French mathematician who first described it accurately. It causes a clockwise drift in the northern hemisphere, while south of the equator a moving object is pulled to the left of its course. Coriolis force has been important so far in considering winds and currents: it exerts such considerable influence upon a mass such as the North Atlantic that it causes a slope in the surface of the ocean, which in mid-Atlantic is as much as forty-eight inches above the level of American coastal waters. Its effects upon supertankers have not yet been adequately defined, but they have been sufficiently established to show that they may have to become a part of practical seamanship in future, especially in dangerous waters: if a particle of sufficient mass moves eastward, increased centrifugal reaction causes it to move toward the equator; if it moves westward, lower centrifugal force moves it toward the pole.

Conning these ships means a revised set of judgments and reflexes for what such a long, wide vessel can or cannot do in harbor or in an emergency such as a collision situation. The whole experience is so completely different and dangerous that the Esso Oil Company trains its masters aboard miniature exact-scale models of VLCCs on an eight-acre lake near Grenoble, France, whose facilities include scale models of piers, sea berths, loading buoys, and typical narrow channels; and at Delft, Holland, tanker crews can be trained in a simulator similar to those used for flight crews and offering the facsimile bridge of a 250,000-ton tanker. It is the only one of its kind and it gives men the exact experience of taking these ships into port and docking and undocking them in all sorts of weather, as well as in various situations that might arise in the open sea. It is a comparatively lucky few who are sent to Grenoble or Delft to train—usually the masters for the big oil companies. Most VLCC masters have to learn on the job, which can be a terrible ordeal of caution and doubt.

Guiding and steering a ship from a bridge set nearly a quarter of a mile from the bows is frightening enough to a man unaccustomed to it, but he also is one hundred feet above the water and has to walk one hundred and fifty feet from port to starboard to see what is happening on the other side: even on the *Queens* the bridge was reasonably



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close to the bows, and anyway moving one of those ships in or out of dock was normally a huge joint effort of ship and shore and fleets of tugs.

Even on the open water supertankers need plenty of sea room. They cannot respond to split-second timing. It takes at least three miles and twenty-one to twenty-two minutes to stop a 250,000 tonner doing sixteen knots: overlong hulls create different forces of momentum, giving the effect of a lower resistance to the water, despite the awkward blunted shape, and sheer weight seems to augment this and to keep them rolling on and on and on. The Ship Division of Britain's National Physical Laboratory found that a 100,000 tonner may lose only one knot per minute while attempting to stop. At very low speeds such as those advisable in fog mammoth ships may be unable to maneuver at all. Between four and five knots a 30,000 tonner easily loses its steerage way and starts sheering off its course, unless helm and engines are skillfully used. Under these circumstances, trying to stop or maneuver a VLCC on the open sea is tricky enough when attempting to avoid collision or to retrieve a man who has gone overboard, these being the most common of

emergency maneuvering situations, but in confined and crowded and shallow waters it is infinitely more so, and sometimes impossible.

★ ★ ★

In many areas supertankers sail with a clearance of as little as two to three feet. The danger of striking even the most modest obstruction on the bottom is increased by the fact that supertankers tend to squat by the bows, and in ships over 200,000 tons this can be by as much as three to four feet; this squat is worsened by quite ordinary wave effects, tidal surges, and currents. The Ship Division of Britain's National Physical Laboratory has also found that these ships are affected by shallows even when they have what appears to be more than sufficient water under their keels. Their maneuverability is sharply diminished once the water under their keel becomes the equivalent of forty feet of their draft. When, say, a ship of fifty-foot draft still has twenty feet of water under her keel her turning circle is doubled; that is, when her helm is put over the turn is only half as tight as it would be in deeper water. The danger of this is that the ship's compass itself indicates that

(Please turn to page 196)

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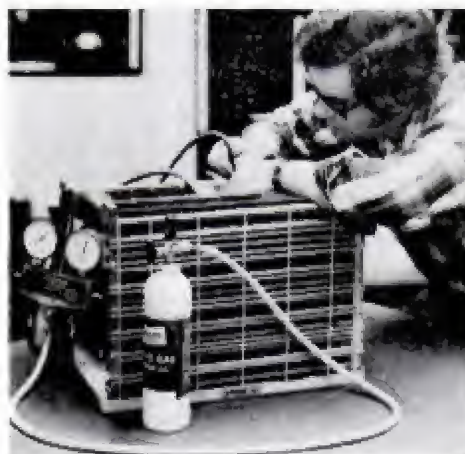
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the ship is turning normally when in fact she is making a far bigger circle than her master might suppose. When water under a VLCC is down to three feet, the ship is virtually unsteerable, the Ship Division of the National Physical Laboratory has found. Touching bottom on the sandy Straits of Dover is not quite as dangerous as doing so in the Malacca Straits, where the seabed is granite. On one occasion two Japanese VLCCs within the space of one week holed themselves inexplicably on the floor of the Straits, when they had supposed that they had sufficient water.

In 1967 it cost three dollars and twenty-nine cents per ton of oil in an 80,000 tonner to make the round trip from Rotterdam to Kuwait at the head of the Persian Gulf and back, going through the Suez Canal both ways. A 200,000 tonner could carry the same oil between the same points but via the Cape for less than two dollars and forty cents a ton, making the longer route considerably cheaper than the traditional shorter one, and putting question to the future of the Suez Canal even if it did reopen.

The older tankers get, and for a VLCC five years means it is getting on, the greater the wariness about them. At five years they are at the halfway point of their write-off lives. The first generation of very big ships, the early 200,000 and 250,000 tonners, already is either at that stage or about to reach it. These ships are now traveling up the North American east coast to the Canadian terminals that already serve them in these waters, and they are the ones that will dominate the American terminals, it and when they come. But why pick on one generation? Five years is not a long time, except to a dog or a cat, whose span at that is half again as long as the calculated one for a VLCC and any ship commissioned this year will be showing its age before the end of the decade.

Holding such a ship together beyond the five-year point may be onerous and difficult, but doing so after ten years will be nightmarish. That is when they will start changing hands. Inevitably they will pass on to some flag of convenience owner who would not be buying them if his standards were precise; that there will be eager buyers there can be no doubt about, unless some radical momentum affects international cooperation at sea and stringent new regulations make the operation of such vessels impracticable. Such a prospect is not credible. So we should prepare ourselves.

minimum distance from the center of the lens element to the camera's focal plane with the bellows collapsed should equal the lens's focal length of 762-mm (30 inches). It's best to cut the pipe a little long, and trim it later.

The seven internal baffles are two-inch-diameter sandwiches of heavy, noncorrugated cardboard (for rigidity) and aluminum foil (for precision). Cut a 1 1/4-inch hole, centered within each cardboard disc, and a precisely centered 1 3/16-inch hole in each foil piece. Nearly perfect circles can be cut by chucking a rod-shaped knife blade (such as X-Acto No. 9B) in place of the pencil lead in a drawing compass, or taping a flat knife blade to the compass leg. First cut the discs' outer diameters, then the inner holes. Glue each aluminum disc to its cardboard backing with spray photo-mounting cement. Spray discs flat black, making sure all aluminum edges are painted; spray the pipe's interior, too, and let it dry.

To insert and position the baffles, cut a 1 7/8-inch disc of wood and nail it to a 3-foot dowel. Mark the dowel at each of the following distances from the far surface of the wood disc to help you position the baffles correctly:

Baffle No.	Distance From Camera End of Pipe
1	20 5/16"
2	16 7/16"
3	12 15/16"
4	10 1/8"
5	8"
6	6 1/4"
7	4 15/16"

Push each baffle into position with the disc and dowel; they should be a tight enough fit to stay put without gluing. Now line the inside of the pipe between baffle number 7 and the camera end with black velvet. Fasten a T-mount adapter for your camera to this end of the pipe with epoxy or hot glue. Center the adapter carefully and make sure the joint is light-tight, painting it, if necessary, once the glue dries.

Now insert the lens element, by hand, about 1/4 inch (half the lens's thickness) into the other end of the pipe; it should fit tightly. Temporarily attach the bellows and camera to the lens and focus on a distant object. If the lens won't focus at infinity, you'll have to remove the lens element by wrapping a camera strap around the protruding portion of its edge to pull it out. Then cut a bit off the lens end of the pipe, first stuffing a rag into the pipe end to

keep sawdust out. You can cut off a bit at a time, by trial and error (if you cut off too much, the lens will focus past infinity); or you can calculate the required cut from the closest subject distance you can focus to, using the following formula: For a subject distance of d inches, the amount to cut (in inches) is:

$$\frac{30d}{d-30} - 30$$

Trim only the lens element end of the pipe, making sure to keep the end square.

The tripod mount shown is optional—bean-bags, one at each end of the lens, seem to work as well or better. But if a tripod mount is more convenient, construct the V-block as shown, just deep enough so that its bottom will be even with the bottom of your bellows, as shown. Align V-block and lens so the bottoms of the block and bellows are parallel when the bellows is mounted, and attach it to the pipe with hot glue or epoxy. Attach the V-block to the bellows-support board with wing bolts, so you can remove the board to mount or dismount the bellows (if you have a Canon mount, this won't be necessary).

Insert a 1/4-20 Teenut as close as possible to the center of gravity, with lens and camera mounted, to take the tripod screw.

The aluminum brace shown is optional, but recommended for exposures longer than 1/30 second. The block that fits the tripod is drilled or split to fit around the tripod column, with another bolt hole coaxial with the tripod tilt-head's pivot; if the two aren't coaxial, the tripod won't tilt with the brace attached. One end of the aluminum strap is bolted to this hole in the support block, while the other is fastened to the lens as indicated on the diagram. The first nut holds the bolt to the lens barrel; the second holds the brace.

If the tripod design permits, it might be simpler to drill and tap a hole in the tilt-head pivot itself and attach the brace to the tripod with a wing bolt, instead of making up the block shown.

A straight pipe connector can be slipped onto the lens element end of the pipe for a sunshade. Its interior should be painted flat black or covered with black velvet.

On some types of plastic pipe, the exterior can be cleaned with a little acetone on a rag. But other types of plastic gum up when acetone is used, so be sure to test first on a piece of scrap. ***

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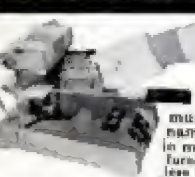


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HANG YOUR PICTURES TO STAY

(Continued from page 107)

can be attached to the wall for hanging lightweight pictures. They are especially useful for metal partitions or walls where nails are prohibited.



Apply masking tape to plaster wall where you'll nail hook to help prevent chipping.

To hang heavy pictures on hollow walls, use screw anchors or toggle bolts. Anchors of various shapes and lengths are made of plastic, nylon or metal. Most require a predrilled hole; some have a point on one end and can be driven into a wall with a hammer. Turning a screw causes the anchor to expand and hold firmly.

Toggle bolts have wings that fold to pass through a hole in the wall, then spread out. Then, when a bolt is turned the wings hold it tightly against the inside of the wall.

Securing a hanger in cement, cinder block or brick is not as hard as it sounds. Masonry nails can be driven into freshly poured cement, but after a few years the cement becomes harder and so does the nailing. A special hanger with needlelike pins that you can drive into cement or cinder block will hold well for small pictures. Screw or expansion anchors work for heavier jobs, but a predrilled hole is needed. To drill it, use a hammer and star drill or a carbide-tip bit in a variable-speed electric drill at slow speed.

You needn't be an interior decorator to decide where to hang a picture. Most pictures should be hung at eye level so it is important to consider whether a person will be sitting or standing while looking at them. Do not hang pictures with small detail where close viewing is difficult, such as over a couch. A busy background like a patterned or flowery wallpaper can be distracting for most pictures except possibly large ones with dark, bold colors.

Contrasting colors of picture and wall make a picture appear larger; similar shades make it seem smaller. Don't hang pictures over heating ducts or in drafts of dust-carrying air. And avoid direct sunlight and fluorescent light to prevent fading of artwork and framing materials.—John W. Spencer.



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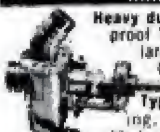
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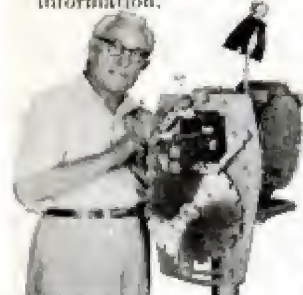
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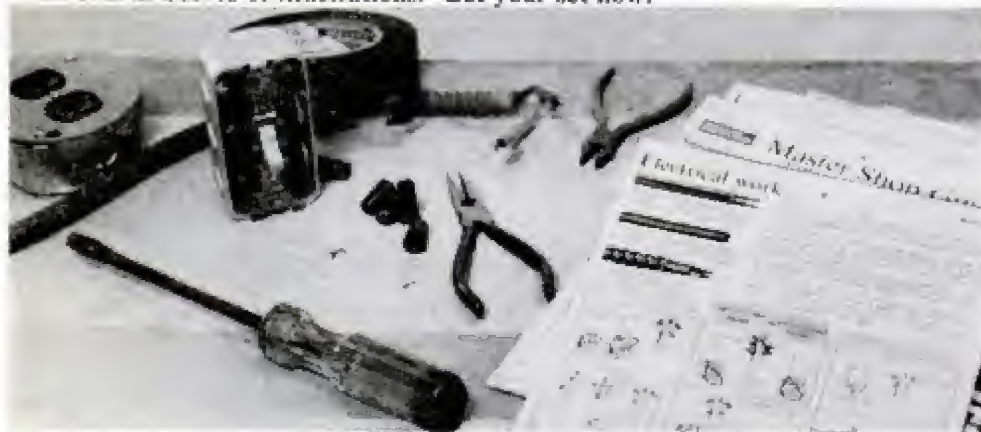


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PROJECTS IN PLASTICS

(Continued from page 73)

bore holes by hand. To do it, back the plastic with a clamped block of wood and be sure the drill is sharp.

To bore with power, use a specially ground high-speed twist drill (available at plastics stores). For best results, use a slow speed and minimum pressure: Too fast and the plastic will spin with the bit, while too much pressure causes chipping on the back side of the hole.

■ **Edge finishing.** There are three finishes—smooth, satin and transparent. No matter which one you want, first remove all cutting-tool marks with a medium fine-tooth file.

For a smooth finish, scrape edges with a sharp piece of metal or sand them with medium-grit (60-80) production paper. For a satin finish, continue to sand with increasingly finer (220-320) wet-or-dry paper. For a transparent finish, sand with finer grits (400-500) wet-or-dry paper and then buff the edges with a clean muslin wheel dressed with a good grade of fine-grit buffing compound. (Note: Buffing kits, with compound, are sold at plastics dealers.)

■ **Cementing.** Solvent (capillary) cement can be used with Plexiglas G and similar sheet acrylics. Finish edges to be cemented to the satin-finish stage and remove protective paper. Hold the pieces together with several strips of masking tape at each joint and apply solvent with applicator while keeping the cemented joint horizontal.

A thickened cement gives strong joints and good outdoor weatherability; it can be used with types G and K Plexiglas. Again, sand edges to a satin finish, but do not polish. Remove paper and apply a small bead of cement to the joint. After joining pieces, keep the workpiece clamped for two hours.

■ **Bending.** To make a bend, you will need a strip heater (see page 162, Nov. '73). The line to be bent is positioned over the heating element until it softens; then the plastic is carefully bent to the desired angle. For complete bending instructions, refer to the article mentioned above. In any event, *do not* heat sheet acrylic in your oven.

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DRIVING CADILLAC'S SEVILLE

(Continued from page 105)

steering linkage, plus a lot of sound-
deadening in every nook and cranny.

Another interesting Seville innova-
tion: body bolts that use microen-
capsulated epoxy. When these bolts
get tightened at the factory, the little
capsules pop and let out the epoxy.

Some standard equipment in the 1975 Cadillac Seville

Automatic airconditioning
Automatic load-leveling
Digital clock
Electric deck-lid release
Electronic fuel injection
80-amp. alternator
Power front-disc brakes
Electric door locks
Variable-ratio power steering
Power windows
Six-way power seats, reclining
AM/FM stereo radio
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Padded roof cover
Steel-belted radial tires
Tilt/telescope steering wheel
Turbo Hydra-Matic 400 transmission
Seat-belt warning chimes
Fuel monitor
Trunk carpeting



high idle to waste gas. The Cadillac
people tell me this car gets about 14
to 15 mpg overall with its standard
2.56:1 rear axle.

One drawback of the f.i. system is
that it's complicated—so much so
that no one but a factory-trained me-
chanic ought to work on it. The way
the f.i. works is interesting. Its
"brain" is a little solid-state com-
puter that lives under the radio. This
computer has been programmed for
every conceivable driving variable—
road/load conditions, ambient and
engine temperatures, altitude, hu-



Interior treatment is Cadillac all the
way. It's comfortable and luxurious.

midity, etc. The system has sensors
all over the place. The brain reads
these sensors and meters the right
amount of fuel to each cylinder via
timed pulses. Fuel is injected directly
into each combustion chamber near
the intake valve.

Cadillac has gone beyond the call
by providing a number of little extra
touches; for example, automatic load-
leveling integrated into the rear
shocks, a never-needs-water battery,
three-note horns, ding-dong seat-belt
alarm instead of the usual buzzer, a
rear-window defroster, real wood
trim, lots of lights inside the car,
slotted dashboard defroster grilles
to keep pencils and coins from rolling
down them, plus quite a lot more—
little things that make the Seville
worth Cadillac's immodest price (it'll
be tagged at about \$11,000).

Otherwise, the car's basic engi-
neering is straightforward enough.
Cadillac tried all the unusual power
train arrangements, including front-
wheel drive, but the conventional lay-
out turned out to be the most prac-
tical.

In this price class, there's no way
for prospective buyers to avoid a
comparison between the Seville and
Mercedes-Benz models. Whether the
Seville will stop the rush to Mercedes
on the part of increasing numbers
of sophisticated car buyers remains
to be seen. ★★

The epoxy then hardens in place.
Look, Ma, no lock washers! But pity
the poor bodyman who has to replace
a fender.

While on the topic of the Seville's
body, I should mention that Cadillac
has gone to considerable length to
prevent rusting. The cowl section
plus rear quarters, wheel-houses, and
all door outers use Zincrometal—steel
with a mechanical zinc coating on one
side. Inner and outer surfaces of
rocker panels are galvanized, as are
most rear-end sheet-metal stampings.

The Seville uses Oldsmobile's 350-
c.i.d. V8, but adds to it the Bendix
electronic fuel-injection (f.i.) system.
The main purpose of the Seville's f.i.
is to improve driveability. I noted
instant throttle response, for ex-
ample, with no flat spots and no ten-
dency to diesel after shutdown. And
since f.i. eliminates the need for a
choke, there's no cold-start problem,
no pedal pumping, no hesitation from
standstill on chilly mornings, and no

CITIES IN THE SKY

(Continued from page 97)

chine, the "Transport Linear Accelerator" (TLA), is a "mass driver," as O'Neill calls it. It is similar to a linear accelerator of nuclear particles. Instead of particles, however, it uses solar electric power to accelerate buckets of compacted moon ore along a six-mile course until they reach escape velocity, then slings them out into space toward a colony under construction. At the construction site, pickup vehicles would scoop up the free-flying bundles of ore and bring them in to the colony.

Another advantage of the system, notes O'Neill with a gleam, is that it also can serve as a reaction motor—it not only can hurl loads in one direction, but using the loads themselves as a reaction mass can also push something in the opposite direction. "Using any kind of moon slag or asteroidal debris as a reaction mass," says O'Neill, "it can be used to propel payloads in the 100,000-ton range or higher."

Imagine what this could mean. In the asteroid belt, for example, there are great clods of pure nickel-iron floating around that could easily be processed into steel if they could be moved to an L5 construction site. Many meteoroids are thought to be rich in hydrocarbons and water—both essential to a space colony. Hitch a TLA to one of these chunks and, by spewing out bits of it in one direction, you could shove it—even an entire asteroid—in the opposite direction toward your colony site.

To make construction in space possible without the need for cumbersome space suits, scientists have devised giant aluminum spheres that can be pressurized and heated to permit work inside in a shirt-sleeve environment. Parts for a colony would be fabricated one at a time in modules inside the spheres. As each module is completed, the sphere around it would split apart in two halves to permit its removal, then the halves would close again for work to begin on the next module.

Basic construction of a typical colony cylinder would consist of a web-like framework of cables and ribs—the cables running lengthwise to hold the four-mile-diameter end caps in place against the internal atmospheric pressure and ribs or cables running circularly around the circumference to contain the pressure and centrifugal force against the sides. Over this skeletal framework would be fastened steel, aluminum or titanium plates to form the opaque walls for the land areas. The transparent "window" strips in between would

be glass panels reinforced by woven steel mesh.

Each colony would have a solar power station of paraboloidal mirrors encircling the after end of the cylinder, focusing the heat on boiler tubes. Conventional turbine generators would provide the entire community with a potential of 10 times the power per person available on Earth. Oxygen from plentiful lunar oxides would be combined with liquid hydrogen to produce water.

Inside each colony, population density would be low since all industrial and agricultural activities are kept outside. There would be about 100 square miles of forest and parkland to provide pleasant surroundings. Since the entire community would be heated as a unit by solar energy, there would be no need for individual heating systems. No fuel-burning cars would be allowed—only bicycles and small pollution-free electric cars.

As for sports, you'd have everything you can do on Earth—plus a few you can't do here. In winter-time, snow would fall for skiing in the mountains—mountains, incidentally, created from moon rock and soil. All sorts of trick sports involving low gravity could be performed at the higher levels where gravity decreases or in special pods outside the main cylinder. Skin diving in space would be a unique experience. This could be done, notes O'Neill, in one of the external pods filled with water and fish. Slow rotation would produce low gravity, thus eliminating pressure-equalization problems. Noisy and pollution-producing sports—like car racing—would also be possible, but would be confined to pods in the outer ring.

What about hazards of radiation and meteoroid damage? No problem, say the scientists. The metal skin, soil and the depth of atmosphere will take care of cosmic rays. As for a meteoroid striking a colony, the chances are slim—once in a million years for a one-ton chunk to collide is the estimate of NASA experts. And even if one did hit, damage would be slight and localized—not severe enough to endanger the community. One Princeton researcher has calculated that a hole in the skin the size of a window opening would incur a leakdown (depressurizing) time of 300 years!

Aside from all the obvious advantages of space colonization, the greatest impact in the end, perhaps, may be psychological—when people realize they are no longer on a doomed planet. With positive attitudes and hope for humanity restored, new horizons for progress on Earth may be as sweeping as space itself. ★ ★ ★



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Rack for lathe tools



Box holds 12 turning tools, hangs on wall when not in use. It can be hung on nearby drawer (see sketch below) for turning sessions.

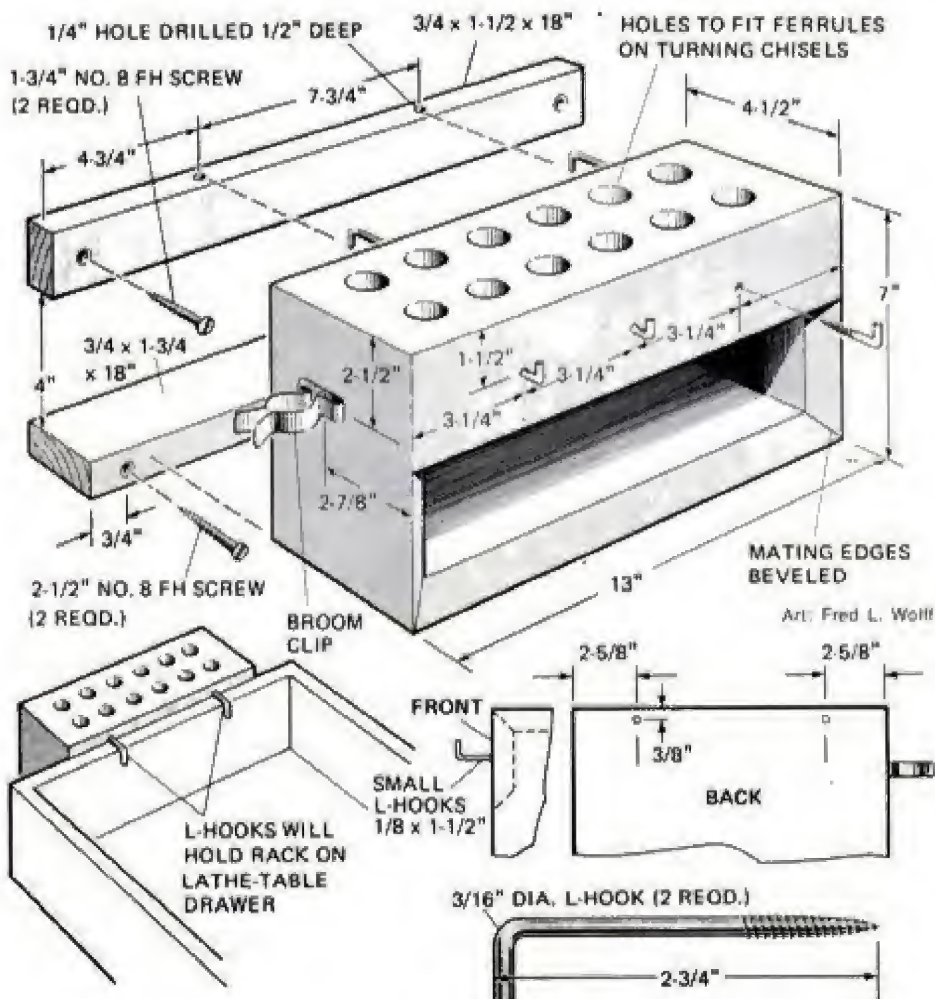
Lathe buffs will be interested in this handy rack for storing lathe tools conveniently and safely. Made of birch, the box shown holds 12 tools; for more, simply lengthen the box.

For easier cleaning, front edges are bevel-cut to 45°. Joints (except for the back which is let into edge rabbets) are also bevel-cut.

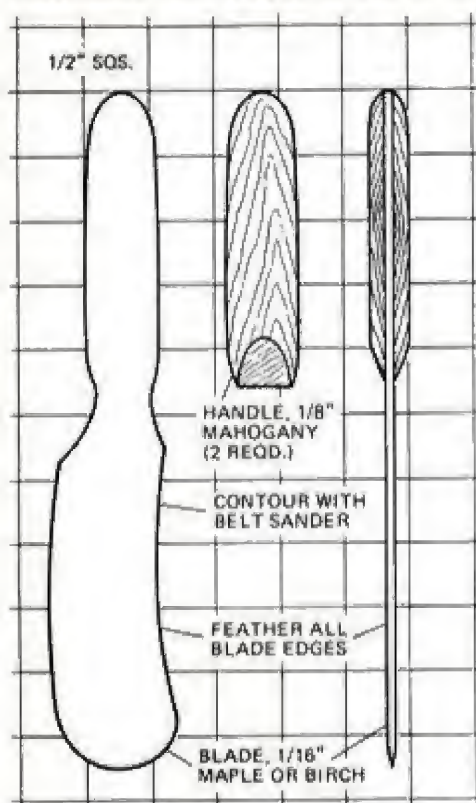
Carefully cut all parts to sizes

shown and join them with white glue and finishing nails through pre-drilled holes. There's no need to clamp the setup while glue dries; the back, which goes on last, holds the piece perfectly square.

Use small L-hooks to hold calipers, dividers and other tools on front. Larger L-hooks on the back will let you hang box on a wall or drawer edge.—John P. Bainbridge



Wooden cheese spreader



Perfect for soft cheese and other spreadables, this wooden paddle has a center piece of birch or maple. Its handles of walnut parts are cut using a jig or coping saw and glued together with white glue (using rubber bands as clamps). For greater resistance to moisture, join parts using contact cement. Shape the spreader's contours with a 120-grit belt on a sander/grinder, then finish sanding with a 220-grit belt. Finally, fill the hardwood and, when dry, rub the spreader with mineral oil. (Don't use a toxic varnish.)

—Mel Crosby, Cape Cod, Mass.

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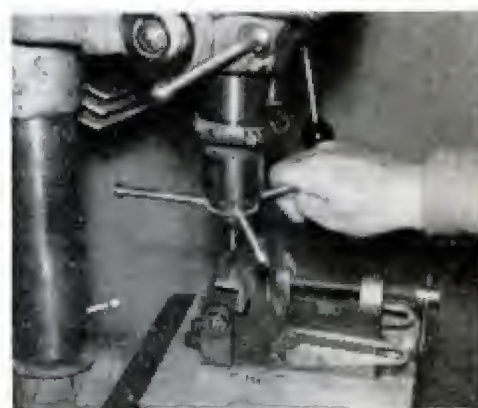
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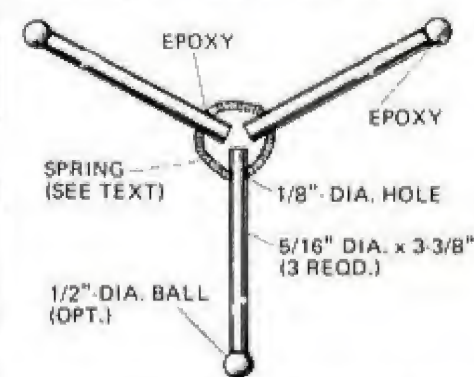
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Dimensions shown above are approximate and may be varied; your drill press's chuck may, for instance, have key holes of 1/4-in. dia. rather than 3/16 in. A spring holds the handles in the chuck so they can be quickly slipped on or off. It passes through holes drilled crosswise in the rods. To find the right drill point, insert a rod in the chuck and mark it so the spring will just clear the chuck. Drill all three rods alike. Cut the spring to a length that provides snug tension on the rods, then thread it through the rod holes. Dabs of epoxy will hold the spring ends together and keep the rods evenly spaced. If you don't have a suitable spring handy, a typewriter repair shop is a good source.

Small steel balls epoxied into recesses in the handle ends are optional for good looks and a good grip. Be sure to disconnect the power cord before inserting the handles so the drill press can't accidentally start up.

—William G. Waggoner



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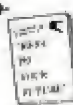
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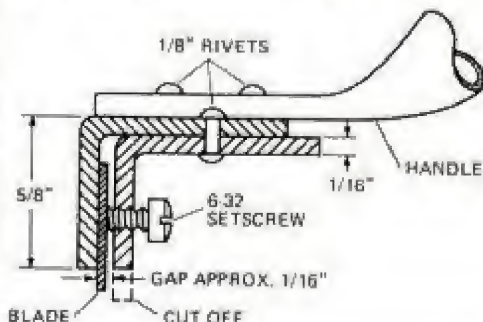
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Tool scrapes shallow grooves in wood surface offering extra tooth for glue to grip.



This simple tool was made from odds and ends for roughening wood surfaces to be glued. It can also be used to remove rust scale or paint scale and blisters. Basically, it is a holder for a short length of hacksaw blade. With a smooth-edged blade, it can be used as a conventional scraper.

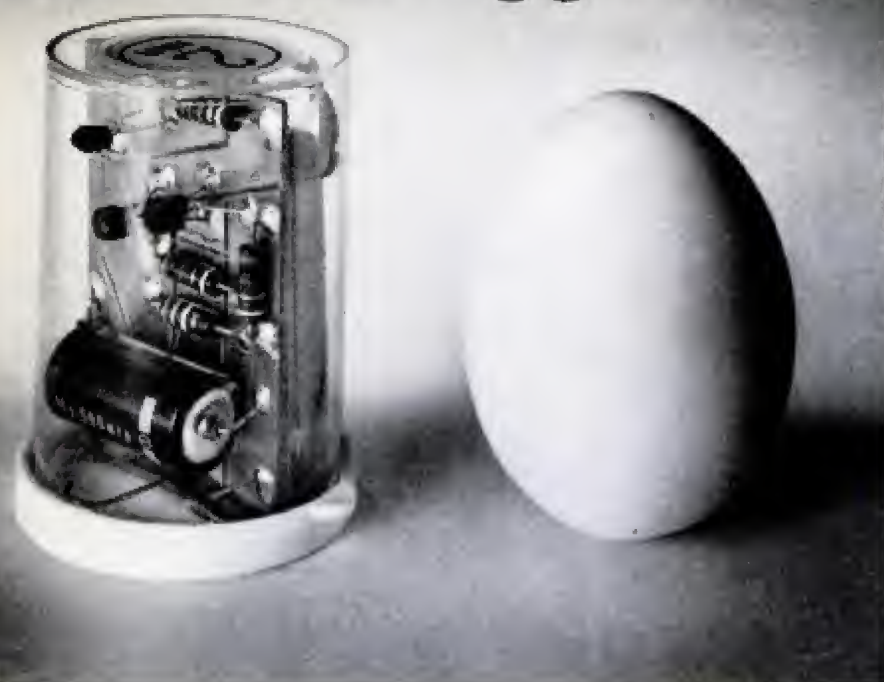
The body consists of two pieces of steel angle, 2 in. long, fastened together with $\frac{1}{8}$ -in.-dia. rivets, with a gap of about $\frac{1}{16}$ in. to accommodate the blade, which is held in place by three 6-32 setscrews in the inner angle piece. An overlap of about $\frac{1}{8}$ in. was trimmed from this inner piece. The handle, made by flattening one end of a $\frac{1}{2}$ -in.-o.d. metal tube 7 in. long, is secured with two $\frac{1}{8}$ -in. rivets passing through both angle pieces. The parts used happened to have the dimensions shown but similar pieces could be used.

Hardened hacksaw blades can be cut with an abrasive cutoff wheel, or by grinding through with the edge of a grinding wheel. Safety goggles should be worn. Any attempt to snap such a blade is a hazardous undertaking as sharp-edged fragments can fly with force in any direction.

—Walter E. Burton

Electronic egg timer

by Richard F. Cutler



Three-minute sand-glass egg timers are cheap and easy to reset with one hand—but what if you want one for two minutes? Or four? For about four dollars and change, you can build this electronic kitchen and darkroom equivalent for any time from two to six minutes. It's small enough to fit inside of a pill bottle.

There is no switch: Just turn the vial cap upside down and back again, and the light-emitting diode (LED) inside the case glows for whatever time period you've selected, then goes out. Current drain is so low (about 10 milliamperes on, about 5 microamperes off) that the battery will last nearly its normal shelf life. With no external switch, the timer is waterproof—ideal for kitchen and darkroom alike.

The simple circuit is built on a piece of single-sided, copper-clad circuit board cut to fit the vial. Trace the pattern shown at right on the copper with a pencil, cut along the lines with a hobby knife, and remove unwanted material with tweezers. Make the component holes with a No. 60 drill and solder components to the copper side.

The transistors aren't critical; almost any silicon NPN devices with d.c. current gain (h_{fe}) of 100 or more and a voltage rating (V_{ceo}) of over 15 volts will work. Resistors can be ½-watt, ¼-watt or ⅛-watt.

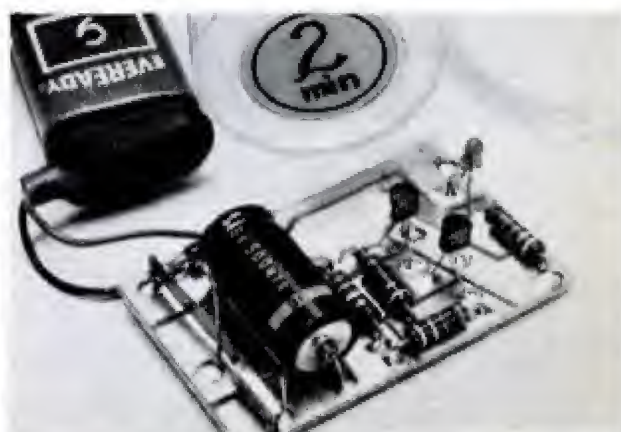
The timer's duration depends on the value of R2; exact values will depend on other components in your circuit, but try these:

Minutes	R2
2	130K
3	200K
4	270K
5	360K
6	430K

(Beyond six minutes, the LED takes too long to go out; it's hard to tell when the time period is over.)

Turning the timer on is a gravity-operated switch (S1) made from a strip, about 3/32 inch wide, of thin, flexible brass shim stock or thin copper sheet found in hobby shops, with a small brass weight soldered to its free end, as shown. The switch contacts are short pieces of resistor lead. Make the bottom switch contact long and hook-shaped to act as a leg to steady the circuit board in the plastic case.

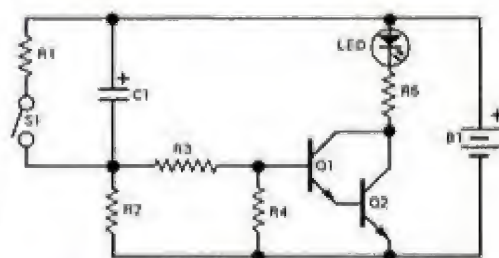
Clip component leads close as possible to back of the board; cover them with felt to avoid shorting them across the battery's case.



Component-location diagram can also be used as a pattern for cutting copper circuit board.

PARTS LIST

- S1—Gravity switch (see text)
- R1—100-ohm, 5% resistor
- R2—5% resistor (see text)
- R3, R4—1-meg., 5% resistor
- R5—510-ohm, 10% resistor
- C1—500-mfd., 15-v. electrolytic capacitor (Radio Shack No. 272-1007)
- LED—Red (Radio Shack No. 272-042)
- Q1, Q2—Transistor, NPN, 2N3904, 2N2222, 2N1613 or equivalent (Radio Shack No. 276-2016, 27-901, etc.)
- B1—9-v. transistor battery
- Misc.—Plastic pill vial (20DR), circuit board (copper-clad one side only), clip for 9-v. battery, felt or cardboard insulating sheet.



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Add an emergency alarm to your wireless garage opener

by Russel V. Puterbaugh

Photos by the author



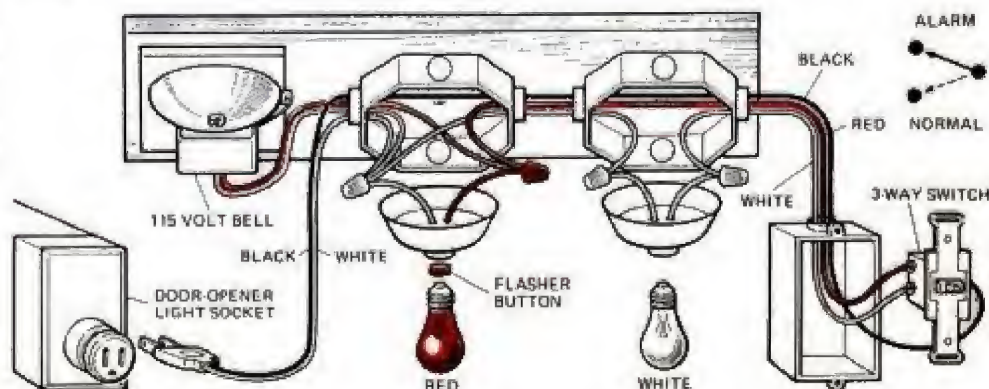
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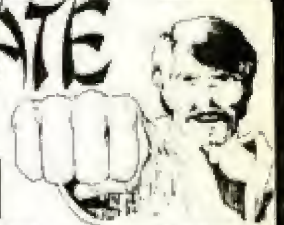
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HOMEWORKERS—Mailers Wanted! Free Information, A. Allen, 2418 Lori, Santa Ana, California, 92706.

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(Continued from preceding page)

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(Continued from preceding page)

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